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PRELIMINARY AIRWORTHINESS EVALUATION OF THE UH-60A EXTERNAL FUEL SYSTEM

Michael K. Herbst
Project Officer/Engineer

Paul Losier
MAJ, AV
Project Pilot

Michael Alvin Gleason
Project Engineer

Reginald C. Murrell
CW4, USA
Project Pilot

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Final Report

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Michael K. Herbst, Michael Alvin Gleason, MAJ Paul Losier, CW4 Reginald C. Murrell

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Testing was conducted to determine the effects of the installation of the External Fuel System (EFS) on the performance and handling qualities of the UH-60A helicopter. A total of 27 productive flight hours were flown at Edwards Air Force Base, California between 21 March and 20 May 1988. The evaluation did not reveal any problems that should preclude airworthiness qualification. The installation of the EFS with two 230-gallon tanks caused an increase in power required to hover in ground effect (10-foot wheel height) and out of ground effect of approximately 5 percent and 6 percent, respectively. The change in equivalent flat plate area in the EFS configuration with two 230-gallon tanks varied from 6.2 to 12.4 square feet when compared to the UH-60A in the normal utility configuration. The drag of the UH-60A in the EFS configuration with two 230-gallon tanks is significantly increased when the cargo doors and gunner windows are open. Three shortcomings and two Prime Item Development Specification noncompliances were identified during the handling qualities evaluation of the UH-60A in the EFS configuration. Two of the shortcomings have been noted during previous evaluations of the UH-60A in the normal utility configuration. Handling qualities were not significantly different than those of the UH-60A in the normal utility configuration. Keywords: External fuel tanks; Helicopters; aerodynamics;

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TABLE OF CONTENTS

PAGE

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INTRODUCTION

BACKGROUND

1. The U.S. Army has identified a requirement for intermediate range-extension capability for the UH-60A Black Hawk. To meet this requirement, Sikorsky Aircraft, Division of United Technologies, developed the External Fuel System (EFS), a modified version of the External Stores Support System (ESSS). The EFS has a shorter version of the ESSS wings which attach to the ESSS fixed provisions. The U.S. Army Aviation Systems Command (AVSCOM) directed the U.S. Army Aviation Engineering Flight Activity (AEFA) to conduct a Preliminary Airworthiness Evaluation (PAE) of the UH-60A helicopter with the EFS installed (ref 1, app A). This test request was subsequently amended by AVSCOM to include additional level flight performance tests (ref 2).

TEST OBJECTIVES

2. The objectives of this test were to determine the effects of the EFS configuration on UH-60A performance and handling qualities, to determine airworthiness of the EFS installation and to provide data to support issuance of an airworthiness release to the user. An additional objective was to evaluate the effects of various door/window configurations on level flight performance.

DESCRIPTION

3. The UH-60A Black Hawk helicopter is a twin-turbine, single main rotor helicopter capable of transporting cargo, 11 combat troops and weapons during day, night, visual meteorological conditions and instrument meteorological conditions. The Black Hawk has conventional wheel-type landing gear. The main and tail rotors each have four blades. The main rotor blades and the tail pylon can be folded manually to facilitate air transportability. A movable horizontal stabilator is located on the lower potion of the tail pylon. The helicopter is powered by two T700-GE-700 turboshaft engines each having an uninstalled thermodynamic rating of 1584 shaft horsepower (shp) at sea level, standard day static conditions (30-minute limit, power turbine speed of 20,900 revolutions per minute). Installed dual-engine power is limited by the 2828 shp continuous rating of the main transmission.

4. The UH-60A helicopter (USA S/N 82-23748) used for this evaluation was a sixth-year production Black Hawk which incorporates the ESSS fixed provisions, the reoriented production airspeed probes and the modified production stabilator schedule. A more detailed description of the UH-60A is available in the Prime Item Development Specification (ref 3) and the operator's manual (ref 4).

5. The UH-60A EFS has a shorter version of the ESSS wings. The wings attach to the ESSS fixed provisions with no modification to the aircraft. Each wing has one vertical storage pylon designed to carry an externally mounted 230-gallon fuel tank. A more detailed description of the EFS is contained in appendix B.

TEST SCOPE

6. The PAE was conducted at Edwards AFB, California (elevation 2302 feet) between 21 March and 20 May 1988. Twenty-two test flights were conducted for a total of 27 productive flight hours. The PAE consisted of performance and handling qualities tests of the UH-60A EFS (no-stores and two-tank configurations) and level flight performance tests of the UH-60A EFS (two tanks) with cargo doors and gunner windows open and pilot and copilot doors installed and removed. Flight restrictions and operating limitations observed during the evaluation are contained in the operator's manual (ref 4) and in the airworthiness release (ref 5). Tests were conducted in accordance with the AEFA test plan (ref 6) and an amendment to the AVSCOM test request (ref 2). Test conditions are listed in table 1.

TEST METHODOLOGY

7. Data from the test instrumentation system was recorded by on-board magnetic tape recording equipment, and by hand from indicators in the cockpit. A detailed listing of test instrumentation is contained in appendix C. Test boom pitot-static system data from a previous AEFA evaluation (ref 7) were used to augment data from this test. The baseline data for the performance comparisons were taken from two previous AEFA evaluations (refs 8 and 9). A Handling Qualities Rating Scale (fig. D-1) was used to augment pilot comments about aircraft handling qualities. Flight test techniques and data reduction methods are described in appendix D.

Table 1. Test Conditions[1]

Test	Average Gross Weight (lb)	Average Longitudinal Center of Gravity (FS)	Average Density altitude (ft)	Trim Calibrated Airspeed (knots)	Remarks
Hover Performance	14,040 to 22,420	352.7	2760	0	Tethered and free-flight hover. IGE[2] and OGE[3]. Referred rotor speed between 244.6 & 263.0 rpm[4].
Level Flight Performance	17,240 to 18,970	347.5	3850 to 9710	38 KTAS[5] to 158 KTAS	Referred rotor speed = 258.1 C_T[6] from 0.006974 to 0.009013. Four Configurations: EFS[7] with two 230-gallon tanks; EFS with tanks removed; EFS with tanks with cargo doors and gunner windows open; EFS with tanks with cargo doors and gunner windows open and pilot/copilot doors removed.
Control Positions in Trimmed Level Flight	17,240 to 18,970	347.5	3850 to 9710	35 to 146	Obtained in conjunction with level flight performance tests.
Static Longitudinal Stability	19,020	361.0	6250	79 and 137	Level flight
				78	IRP[8] climbs and autorotational descents
Static Lateral-Directional Stability	19,340	361.1	6060	78 and 135	Level flight
				79	IRP climbs and autorotational descents
Maneuvering Stability	19,210	361.0	6220	79 and 134	Left and right turns
Dynamic Stability	19,160	360.6	6300	79 and 133	Level flight
				79	IRP climbs and autorotational descents
Simulated Single-Engine Failure	18,770	360.6	6240	132	Level flight at V_H[8]
				80	IRP climb

NOTES:

[1]Unless otherwise noted, testing was conducted in the EFS configuration with two 230-gallon tanks, at a main rotor speed of 258 rpm, at a mid lateral center of gravity, with the Automatic Flight Control System ON, all doors closed, the pitch bias actuator centered and electrically disconnected, the environmental control systems and bleed air systems OFF, and in ball-centered flight.
[2]IGE: In ground effect (10-foot wheel height)
[3]OGE: Out of ground effect.
[4]RPM: revolutions per minute.
[5]KTAS: Knots true airspeed.
[6]C_T : Coefficient of thrust.
[7]EFS: External Fuel System.
[8]:IRP: Intermediate Rated Power.
[9]V_H : Maximum airspeed in level flight at intermediate rated power or 100 percent engine torque.

RESULTS AND DISCUSSION

GENERAL

8. Tests were conducted on the UH-60A to determine the effects of the External Fuel System (EFS) installation on performance and handling qualities. The evaluation did not reveal any problem that should preclude airworthiness qualification. The installation of the EFS with two 230-gallon tanks caused an increase in power required to hover in ground effect (10-foot wheel height) and out of ground effect of approximately 5 percent and 6 percent, respectively. Four configurations were tested during the level flight performance evaluation. The change in equivalent flat plate area (ΔF_e) in the EFS configuration with two 230-gallon tanks varied from 6.2 to 12.4 square feet when compared to the UH-60A in the normal utility configuration. The drag of the UH-60A in the EFS configuration with two 230-gallon tanks is significantly increased when the cargo doors and gunner windows are open. Three shortcomings and two Prime Item Development Specification (PIDS) noncompliances were identified during the handling qualities evaluation of the UH-60A in the EFS configuration. Two of the shortcomings have been noted during previous evaluations of the UH-60A in the normal utility configuration. Handling qualities were not significantly different than those of the UH-60A in the normal utility configuration.

PERFORMANCE

Hover Performance

9. Hover performance tests were conducted in the EFS two-tank configuration at the conditions listed in table 1. The tethered-hover method was used to obtain the majority of the data and the free-flight hover method was used for a limited amount. Both hover performance methods are described in appendix D. The data from these tests are presented in figures E-1 and E-2.

10. Hover performance was conducted in ground effect (IGE) at a wheel height of 10 feet and out of ground effect (OGE) at a wheel height of 100 feet. The IGE (10-foot wheel height) and OGE hover capability of the UH-60A in the EFS two 230-gallon tank configuration at standard-day, sea-level conditions was 23,019 pounds and 20,553 pounds, respectively. Test data were compared to data from two previous U.S. Army Aviation Engineering Flight Activity (AEFA) evaluations of the UH-60A in the normal utility configuration (refs 8 and 9, app A). The OGE hover data compare closely with OGE data for the External Stores Support System (ESSS), two 230-gallon tank configuration presented in reference 10. There is no ESSS hover data available for comparison at the 10-foot wheel height. The installation of the EFS with two 230-gallon tanks caused an increase in power required to hover IGE (10-foot wheel height) and OGE of approximately 5 and 6 percent, respectively.

Level Flight Performance

11. Level flight performance tests were conducted to determine the power required and fuel flow at various airspeeds, altitudes and gross weights for four EFS configurations. Test conditions are listed in table 1. Data from AEFA Project No. 83-24 (ref 8) were used as

a baseline to determine the ΔF_e caused by the installation of the EFS and additional configuration changes. Level flight performance tests were conducted for four configurations: the EFS with two 230-gallon tanks, the EFS with no tanks, the EFS with two 230-gallon tanks with cargo doors and gunner windows open, and the EFS with two 230-gallon tanks with cargo doors and gunner windows open and pilot and copilot doors removed. Test results are presented in figures E-3 through E-16.

12. Figure E-3 is a summary of the ΔF_e for the different configurations as compared to the normal utility configuration. In all configurations, ΔF_e varied as a function of airspeed. The increase in drag for the EFS configuration with two 230-gallon tanks varied from approximately 6.2 to approximately 12.4 square feet when compared to the normal utility configuration. Removal of the tanks caused a decrease in drag of 2.5 square feet when compared to the EFS two-tank configuration. The cargo doors and windows open caused an increase in drag of an additional 10.0 to 14.9 square feet when compared to the EFS two-tank configuration. Removal of the pilot and copilot doors did not cause any additional change. This additional drag (doors and windows open) caused the maximum attainable airspeed in level flight (V_H) to decrease by approximately 9 knots true airspeed (KTAS). At airspeeds greater than approximately 70 KTAS, inherent sideslip with the EFS installed (with or without tanks) was approximately 2 degrees further left than the inherent sideslip in the normal utility configuration (ref 8). At airspeeds greater than 70 KTAS, the inherent sideslip with the doors and windows open was essentially the same as with the normal utility configuration. At airspeeds less than 70 KTAS, the inherent sideslip in all configurations tested was up to 10 degrees further left.

HANDLING QUALITIES

Control Positions in Trimmed Level Flight

13. Flight control positions and pitch attitude data were obtained in conjunction with the level flight performance tests and are presented in figures E-17 through E-20. The data presented in these figures show the effects of thrust coefficient on control positions. The trends of control position with airspeed were similar to those of the UH-60A helicopter in the normal utility and ESSS four-tank configurations. The trends of control position with airspeed were essentially unaffected by cargo door, gunner window, and pilot/copilot door configuration. Adequate margins remained for all flight controls throughout the range of airspeed tested. The control position characteristics in trimmed level flight are satisfactory.

Static Longitudinal Stability

14. Static longitudinal stability was evaluated in the EFS, two 230-gallon tank configuration at the conditions listed in table 1. The helicopter was stabilized in ball-centered flight at the desired airspeed and flight conditions. The collective control was fixed at the trim position, main rotor speed was maintained at 100 percent, and the aircraft was stabilized at incremental airspeeds about trim. Test results are presented in figures E-21 through E-23.

15. Static longitudinal stability, as indicated by the variation of longitudinal cyclic control position with airspeed was positive (aft longitudinal control displacement at airspeeds less than trim) in level flight at both airspeeds tested. Weak but adequate control force cues were observed near the trim airspeeds. Static stability was less positive around the trim airspeed of 137 knots calibrated airspeed (KCAS) as compared to the 79 KCAS airspeed but remained positive. The maximum variation of lateral cyclic and directional controls was approximately .75 inches and was not objectionable to the pilot. Static longitudinal stability was positive at 79 KCAS in autorotational flight within 10 knots of the trim airspeed and provided adequate control force cues. The static longitudinal stability of the UH-60A in the EFS, two 230-gallon tank configuration in level and autorotational flight is satisfactory.

16. In an intermediate rated power (IRP) climb, static stability was negative about the trim airspeed of 77 knots. Maintaining airspeed ± 5 knots required moderate pilot compensation (Handling Qualities Rating Scale (HQRS) 4) and was aggravated by small, continuous pitch oscillations in climbing flight. Previous evaluations of the UH-60A in various configurations have noted a neutral static stability in IRP climbs. The static longitudinal stability of the UH-60A in the EFS, two 230-gallon tank configuration in IRP climbs does not meet the requirements of paragraph 10.3.3.1.3 of the PIDS (ref 3) and remains a shortcoming as noted in previous evaluations of the UH-60A.

Static Lateral-Directional Stability

17. Static lateral-directional stability characteristics were evaluated at the conditions listed in table 1. Tests were conducted by trimming the helicopter in ball-centered flight at the desired conditions. With the collective fixed, the helicopter was then stabilized in nonturning flight at incremental sideslip angles up to approximately the limit sideslip on both sides of trim while maintaining the trim airspeed. At the 135 KCAS test condition (slightly below V_H), either engine temperature or transmission torque limits were reached prior to the sideslip limits. Test results are presented in figures E-24 through E-27.

18. Static directional stability, as indicated by the variation of directional control position with sideslip, was positive (increasing left directional control with increasing right sideslip) at all test conditions. The directional control variation with sideslip was essentially linear in level flight, climbs and autorotations and was similar to that reported for the UH-60A helicopter in the normal utility configuration. In climbing and autorotational flight, the directional control variation with sideslip was less than in level flight but was adequate. The static directional stability characteristics of the UH-60A helicopter with EFS are satisfactory.

19. Effective dihedral, as indicated by the variation of lateral control position with sideslip, was positive (increasing right cyclic control with increasing right sideslip) and essentially linear for all test conditions. In level flight, the effective dihedral was less than previous results in the normal utility configuration. In climbing and autorotational flight, effective dihedral was similar to that in level flight. The effective dihedral characteristics of the UH-60A helicopter with EFS are satisfactory.

20. Sideforce characteristics, as indicated by the variation in bank angle with sideslip, were weak but positive (increasing right bank angle with increasing right sideslip) at

78 KCAS in level flight. At 135 KCAS in level flight, sideforce cues were characterized as strong for sideslips greater than 5 degrees in either direction. At approximately 79 KCAS in IRP climbs and autorotational descents, sideforce cues were positive and were similar to the cues in level flight at 78 KCAS. In level, climbing and autorotational flight, sideforce cues were similar to those in the normal utility configuration. The sideforce cues, though weak at low airspeeds, are satisfactory.

21. A strong pitch-due-to-sideslip coupling was evident at the 78 KCAS, level flight trim condition. The longitudinal cyclic position versus sideslip trend was essentially linear up to 10 degrees of sideslip with increasing aft longitudinal cyclic control with increasing left sideslip and increasing forward cyclic with increasing right sideslip. The trend reversed near the sideslip limit. The pitch-due-to-sideslip coupling was much weaker at 135 KCAS. The trend again reversed near the sideslip limit. The strong pitch-due-to-sideslip coupling remains unchanged from that of the normal utility configuration.

Maneuvering Stability

22. Maneuvering stability was evaluated in the EFS, two 230-gallon tank configuration at the conditions listed in table 1. The aircraft was stabilized in ball-centered, level flight at the desired airspeed and load factor was incrementally increased by increasing angle of bank in both left and right turns. Collective control was maintained at the trim position for level flight and the pilot attempted to maintain a constant airspeed. Test results are presented in figure E-28.

23. The stick-fixed maneuvering stability (as indicated by the variation of longitudinal control position with load factor) of the UH-60A in the EFS configuration was positive at 79 KCAS and similar to the UH-60A in the normal utility configuration. At an airspeed of 134 KCAS, the maneuvering stability was negative above a load factor of 1.1. The aircraft exhibited a "dig in" characteristic at bank angles greater than 45 degrees. The negative maneuvering stability of the UH-60A configured with the EFS at load factors above 1.1 at 134 KCAS is similar to that previously reported and remains a shortcoming. The maneuvering stability of the UH-60A configured with the EFS and two 230-gallon tanks failed to meet the requirements of paragraph 10.3.3.1.4 of the PIDS.

Dynamic Stability

24. The short-term and long-term dynamic stability characteristics of the UH-60A were evaluated in the EFS, two 230-gallon tank configuration at the conditions listed in table 1. Dynamic stability tests were conducted in level flight, climbs, and autorotational descents. The Automatic Flight Control System (AFCS) was ON for all tests. The short-term response was excited by making pulse inputs in the longitudinal, lateral, and directional axes. The pulse inputs were approximately one inch of control movement and were held for approximately 0.5 second. Lateral-directional stability characteristics were evaluated using control releases from out-of-trim sideslip conditions. The longitudinal long-term response was evaluated by displacing the aircraft from trim by approximately 15 knots indicated airspeed (KIAS) and returning the controls to the trim position. Representative time-history data for dynamic stability tests are shown in figures E-29 through E-50.

25. The short-term response of the UH-60A in the EFS configuration with the AFCS ON was heavily damped. The pilot was able to correct for aircraft attitude disturbances in all flight conditions tested with minimal control inputs. The short-term response of the UH-60A in the EFS configuration was essentially the same as that of the UH-60A in the normal utility configuration and is satisfactory.

26. The lateral-directional oscillatory response resulting from control releases at out-of-trim sideslip conditions was convergent with the exception of releases from left sideslip in autorotational flight. Releases from out-of-trim sideslip conditions were generally characterized by a convergent oscillation to near trim sideslip with 2 or 3 overshoots of trim. The release from a 19 degree left sideslip (pedals free) in autorotational descent was characterized by a divergent lateral-directional oscillation (LDO) (fig. E-47). After release from the left sideslip, the pedals, driven by the Flight Path Stabilization System, overcorrected driving the LDO divergent. The LDO period was long enough (9 seconds) to allow the pilot adequate time to override the pedal inputs and recover. During instrument meteorological conditions with moderate turbulence, the pilot will be required to override the pedal overcorrecting characteristics thus aggravating a high-workload situation. The divergent LDO during autorotational descents of the UH-60A configured with EFS and two 230-gallon tanks is a shortcoming.

27. The long-term response was heavily damped in level flight with the AFCS ON. The aircraft was displaced from trim by approximately 15 KIAS and the controls were returned to trim positions. The aircraft returned to the trim airspeed (within ± 1 knot) with two or less overshoots. The long-term response characteristics of the UH-60A in the EFS configuration with two 230-gallon tanks, with the AFCS ON were essentially the same as the characteristics of the UH-60A in the normal utility configuration and are satisfactory.

Simulated Single-Engine Failure

28. Aircraft response to simulated single-engine failures was evaluated in level flight at V_H and in an IRP climb at 80 KCAS. Sudden single-engine failure during dual-engine flight was simulated by rapidly retarding the Number 1 engine control lever to the IDLE stop. Representative time history data are presented in figures E-51 and E-52.

29. Response to simulated engine failure in level flight at 132 KCAS was a left yaw of approximately 4 degrees and a slight left roll. The cockpit indications of single-engine failure included illumination of the ENG OUT master caution light, a reduction of power turbine speed and engine torque, and activation of the aural warning tone when main rotor speed drooped below 95 percent. A rapid reduction of the collective control was necessary to prevent the main rotor speed from drooping below the 91 percent transient limit. The response to simulated engine failure in an IRP climb at 80 KCAS was a 3 degree left yaw and 3 degree left roll. Main rotor speed decayed rapidly and a large reduction of collective control was necessary to prevent exceeding the transient rotor speed limit. The response to simulated single-engine failure was similar to the UH-60A in the normal utility configuration and is satisfactory.

Flying Characteristics with Doors and Windows Open

30. Level flight performance tests included flights with the cargo doors and gunner windows open and with the pilot and copilot doors removed. No specific handling qualities tests were conducted in these configurations but the flying characteristics and the effects of the cockpit/cabin wind were qualitatively evaluated during the level flight performance tests. There were no significant handling qualities differences noted when flying in these configurations. The ship's system pitot-static position error was changed by up to 4 knots at airspeeds greater than 70 KIAS when flying with the pilot and copilot doors removed (para 36).

31. The effect of the wind in the cockpit and cabin was evaluated during the testing with doors and windows open. The wind turbulence was noticeable but not objectionable at the conditions flown and required loose objects to be secured. The highest level of wind turbulence in the cockpit and cabin was at airspeeds below approximately 50 KIAS in climbing flight. Wind turbulence in trimmed level flight generally increased with airspeed but did not become objectionable. Cargo door vibration was observed to increase with airspeed and did present a minor problem. On two occasions, while in trimmed level flight at approximately 100 KIAS, the left side cargo door became unlocked and began to slide forward. The flying characteristics of the UH-60A in the EFS two 230-gallon tank configuration with the cargo doors and gunner windows open and with the pilot/copilot doors installed or removed were satisfactory.

VIBRATION

32. The vibration characteristics of the UH-60A were evaluated in the EFS, two 230-gallon tank configuration at the conditions listed in table 1. Vibration data were measured at the pilot station, in the rear of the aircraft cabin, near the left and right tips of the stabilator and at the stabilator actuator attaching point. Vibration data are presented in figures E-53 through E-70. Cockpit/cabin vibration parameters are shown at harmonic frequencies of the main rotor and stabilator vibration parameters are shown at harmonic frequencies of the tail rotor.

33. Cockpit/cabin vibrations were evaluated in level flight at two gross weights and in turning flight at two airspeeds. In level flight, vibration characteristics in the cockpit and cabin were similar at both gross weights shown. The highest vibrations were typically at the main-rotor 4/revolution (4/rev) frequency in the vertical axis. In turning flight, cockpit/cabin vibrations generally increased with load factor and airspeed. The 4/rev vibration characteristics in the cockpit and cabin, in level flight and turning flight were similar to those reported for the UH-60A in normal utility configuration.

34. Stabilator vibrations were evaluated at the same conditions as cockpit/cabin vibrations and were typically highest at the tail-rotor 4/rev frequency in the vertical axis. In level flight, vibration characteristics generally increased with airspeed and were of similar magnitude at both gross weights shown. In turning flight, stabilator vibrations in the vertical axis increased with load factor and airspeed. Vibrations in the lateral and longitudinal axes were generally not affected by load factor but did increase slightly with

airspeed. The accelerations at the tips of the stabilator were higher than at the actuator attaching point with the right tip generally being highest. The highest acceleration measured on the stabilator was 4.3 g at the tail-rotor 4/rev frequency in the vertical axis. This occurred at the right tip in level flight at approximately 58 KCAS.

PITOT-STATIC SYSTEM CALIBRATION

35. The standard ship's pitot-static system (current production design) was calibrated in level flight in the EFS configuration with two 230-gallon tanks. No tests were conducted to evaluate the effects of climbing and descending flight on the position error of the system. The position error was determined for a limited range of airspeed at one gross weight/center of gravity condition using the trailing bomb method. The position error of the ship's system is shown in figure E-71. In level flight, position error varied from -8 knots at 30 KIAS to -3 knots at 112 KIAS. This error does not differ significantly from the error in the normal utility configuration (ref 8) below 80 KIAS but was up to 4 knots different at airspeeds above 80 KIAS.

36. The test boom airspeed system was used as a reference to determine the effects of the various configurations on the ship's system position error. The comparison was made using data from the level flight performance tests and the results are presented in figure E-72. The position error of the UH-60A in the EFS, two 230-gallon tank configuration was not affected by removal of the two tanks and was not affected when the cargo doors and gunner windows were open. There was a change in position error when the aircraft was configured with two 230-gallon tanks, the cargo doors and gunner windows open and the pilot and copilot doors were removed. The change was less than 2 knots at airspeeds below 70 KIAS and increased to approximately 4 knots at higher airspeeds. This change in airspeed position error should be included in the operator's manual.

CONCLUSIONS

GENERAL

37. The Preliminary Airworthiness Evaluation of the UH-60A in the External Fuel System (EFS) configuration did not reveal any problem that should preclude airworthiness qualification. Three shortcomings were identified during the handling qualities evaluation of the UH-60A in the EFS configuration, two of which have been noted during previous evaluations of the UH-60A in the normal utility configuration.

38. The following conclusions were reached about the UH-60A configured with the EFS.

a. The installation of the EFS with two 230-gallon tanks caused an increase in power required to hover in ground effect (10-foot wheel height) and out of ground effect of approximately 5 percent and 6 percent, respectively (para 10).

b. The change in equivalent flat plate area (ΔF_e) caused by the installation of the EFS with two 230-gallon tanks varied from 6.2 to 12.4 square feet (para 12).

c. The ΔF_e of the UH-60A in the EFS configuration with two 230-gallon tanks is significantly increased (10.0 to 14.9 square feet) when the cargo doors and gunner windows are open (para 12).

SHORTCOMINGS

39. The following shortcoming was identified during the evaluation of the UH-60A in the EFS configuration: The divergent lateral-directional oscillation during autorotational descents (para 26).

40. The following shortcomings were identified during previous evaluations of the UH-60A in the normal utility configuration and remain shortcomings. Shortcomings are listed in order of decreasing importance.

a. The negative static longitudinal stability in climbs at intermediate rated power (IRP) at 79 knots calibrated airspeed (KCAS) (para 16).

b. The negative maneuvering stability above a load factor of 1.1 at 134 KCAS (para 23).

SPECIFICATION COMPLIANCE

41. The UH-60A in the EFS configuration with two 230-gallon tanks failed to meet the following requirements of the Prime Item Development Specification.

a. Paragraph 10.3.3.1.3 - The longitudinal static stability is not positive at 77 KCAS in IRP climbs (para 16).

b. Paragraph 10.3.3.1.4 - The maneuvering stability is not positive at 134 KCAS (para 23).

RECOMMENDATIONS

42. The shortcoming reported in paragraph 39 should be corrected (para 26).

43. The shortcomings reported in paragraphs 40 should be avoided in future helicopter design efforts (paras 16 and 23).

44. The change in airspeed position error reported in paragraph 36 should be included in the operator's manual.

APPENDIX A. REFERENCES

1. Letter, AVSCOM, AMSAV-8, 15 June 1987, subject: Preliminary Airworthiness Evaluation (PAE) of the UH-60A External Fuel System. (Test Request)

2. Letter, AVSCOM, AMSAV-8, 11 May 1988, subject: Amendment to AEFA Project No. 87-04 Test Request, Preliminary Airworthiness Evaluation (PAE) of the UH-60A External Fuel System.

3. Prime Item Development Specification, Sikorsky Aircraft Division, DARCOM CP-2222-S1000F, 18 December 1985.

4. Technical Manual, TM 55-1520-237-10, *Operator's Manual, UH-60 Helicopter*, Headquarters, Department of the Army, 8 January 1988 with change 3 dated 12 August 1988.

5. Letter, AVSCOM, AMSAV-E, 10 March 1988, subject: Airworthiness Release for the Conduct of a Preliminary Airworthiness Evaluation of a UH-60A S/N 82-23748 Configured with an External Fuel System (EFS), Project No. 87-04.

6. Test Plan, AEFA Project No. 87-04, *Preliminary Airworthiness Evaluation of the UH-60A External Fuel System*, September 1987.

7. Final Report, AEFA Project No. 86-01, *Level Flight Performance Evaluation of the UH-60A Helicopter with the Production External Stores Support System and Ferry Tanks Installed*, September 1986.

8. Final Report, AEFA Project No. 83-24, *Airworthiness and Flight Characteristics Test of a Sixth Year Production UH-60A*, June 1985.

9. Final Report, AEFA Project No. 86-12, *Airworthiness and Flight Characteristics Test of the UH-60A with the XM-139 VOLCANO*, unpublished.

10. Final Report, AEFA Project No. 82-15, *Airworthiness and Flight Characteristics Test of the UH-60A Configured with the Prototype External Stores Support System (ESSS)*, December 1983.

11. Flight Test Manual, Naval Air Test Center, FTM No. 105, *Helicopter Stability and Control*, November 1983.

APPENDIX B. DESCRIPTION

1. The UH-60A Black Hawk helicopter is a twin-turbine, single main rotor helicopter capable of transporting cargo, 11 combat troops and weapons during day, night, visual meteorological conditions and instrument meteorological conditions. The Black Hawk has conventional wheel-type landing gear. The main and tail rotors each have four blades. The main rotor blades and the tail pylon can be folded manually to facilitate air transportability. A movable horizontal stabilator is located on the lower portion of the tail pylon. The helicopter is powered by two T700-GE-700 turboshaft engines each having an uninstalled thermodynamic rating of 1584 shaft horsepower (shp) at sea level, standard day static conditions (30-minute limit, power turbine speed of 20,900 revolutions per minute. Installed dual-engine power is limited by the 2828 shp continuous rating of the main transmission.

2. The test aircraft, UH-60A U.S. Army Serial Number 82-23748 was manufactured by Sikorsky Aircraft (SA) (Division of United Technologies) and is a sixth-year production version. The pitch bias actuator was centered and electrically disconnected for all tests. The differences between the test aircraft and a standard UH-60A include the installation of an instrumentation system (app C) and the External Fuel System (EFS). The EFS fuel-transfer system was not installed on the test aircraft. The test aircraft with the EFS and two 230-gallon tanks installed is shown in figures B-1 and B-2.

3. The EFS (figs. B-3 through B-6) was manufactured by SA and is designed to carry two 230-gallon fuel tanks. It consisted of a horizontal stores support on each side of the aircraft that attaches to the fixed-provision attachment points, struts that support the horizontal stores support and attach to the lower fixed-provision attachment points, and vertical stores pylons that attach to the horizontal stores support.

4. The airframe fixed provisions include fuselage attachment structure, fuel transfer system plumbing and electrical system hardware. Attachment fittings are located on main fuselage frame members at fuselage stations 295 and 308. Fuel and bleed-air lines and electrical system wires are routed to near the attachment fittings and are capped when not used. Attachment and interface fittings are covered by fairings when not used. The EFS fairings use attaching points common with those of fixed-provision fairings.

5. The horizontal stores support consists of a 3-spar, graphite/epoxy torque box with aluminum fittings for attachment to the aircraft fixed provisions, support struts and vertical stores pylon. Removable leading and trailing edge fairings house the electrical harness and fuel transfer system lines. One fixed-length strut and one adjustable-length strut are used to support each horizontal stores support. The support struts are graphite/epoxy tubes with trailing-edge fairings and attachment fittings on each end. The fixed-length strut has aluminum fittings on both ends and the adjustable strut has an aluminum fitting and an adjustable stainless steel fitting. The vertical stores supports are compatible with either BRU-22A or MAU-40/A ejector racks. The BRU-22A racks were used during this test and were mounted at a 4 degree nose-up angle with reference to the water line. The two 230-gallon fuel tanks used during this test were manufactured by Fiber Technology Corporation of Springville, Utah. The tanks are constructed of fiberglass and weighed approximately 144 pounds each. The tanks were 15 feet, 6.5 inches long and 24.4 inches in diameter at the widest point.

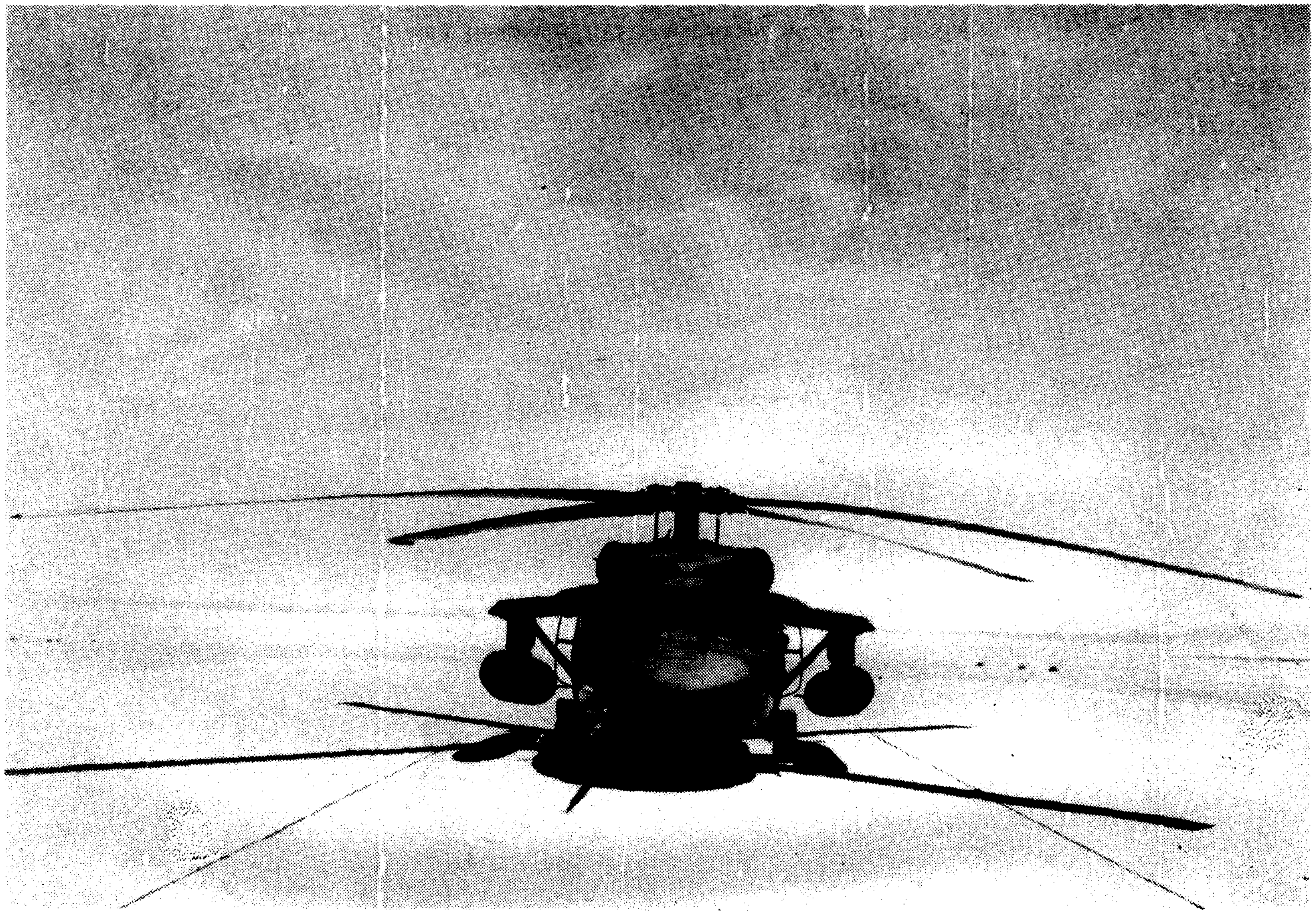


Figure B-1. UH-60A Helicopter, EFS Configuration with Two 230-Gallon Tanks

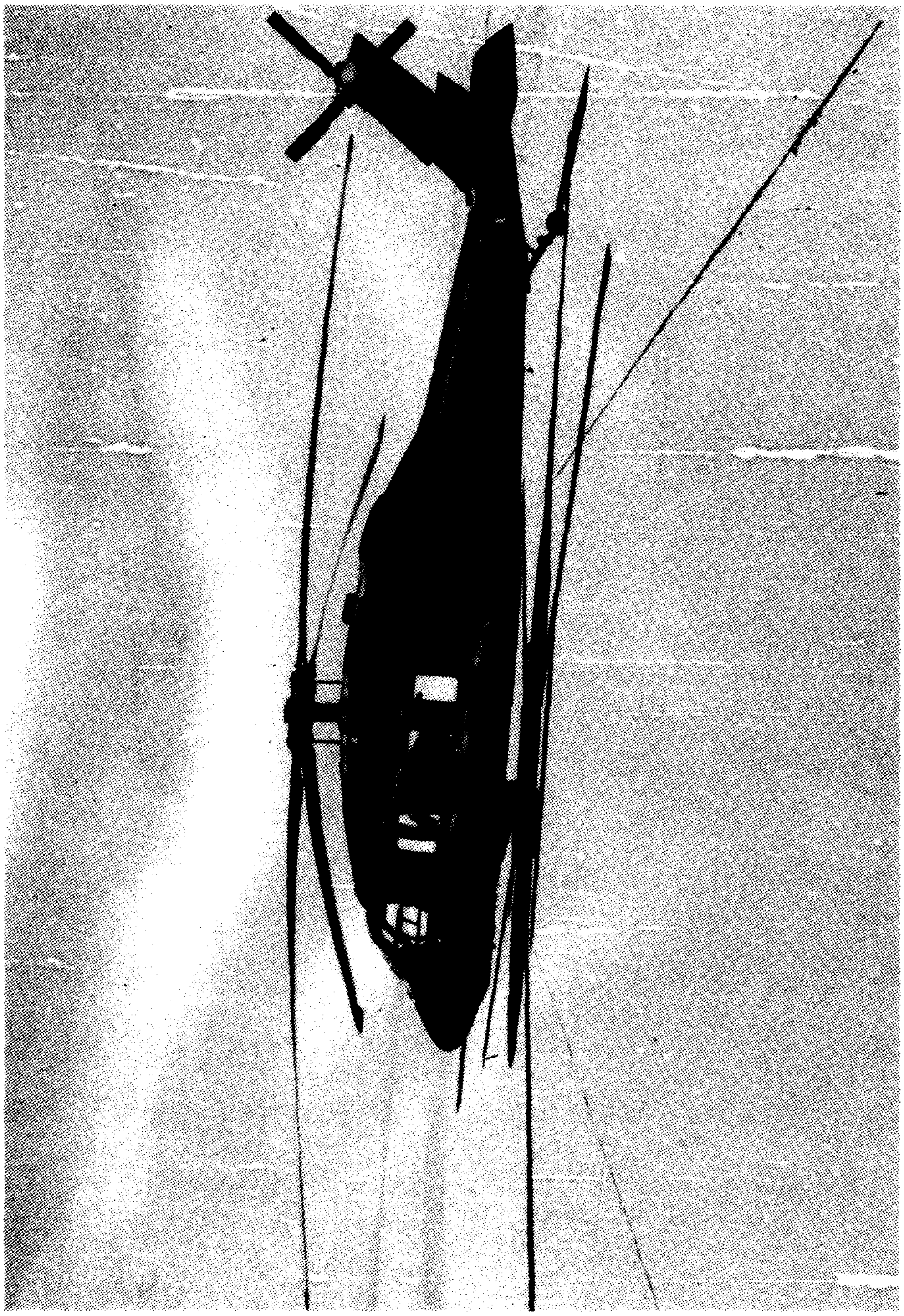


Figure B-2. UH-60A Helicopter, EFS Configuration with Two 230-Gallon Tanks

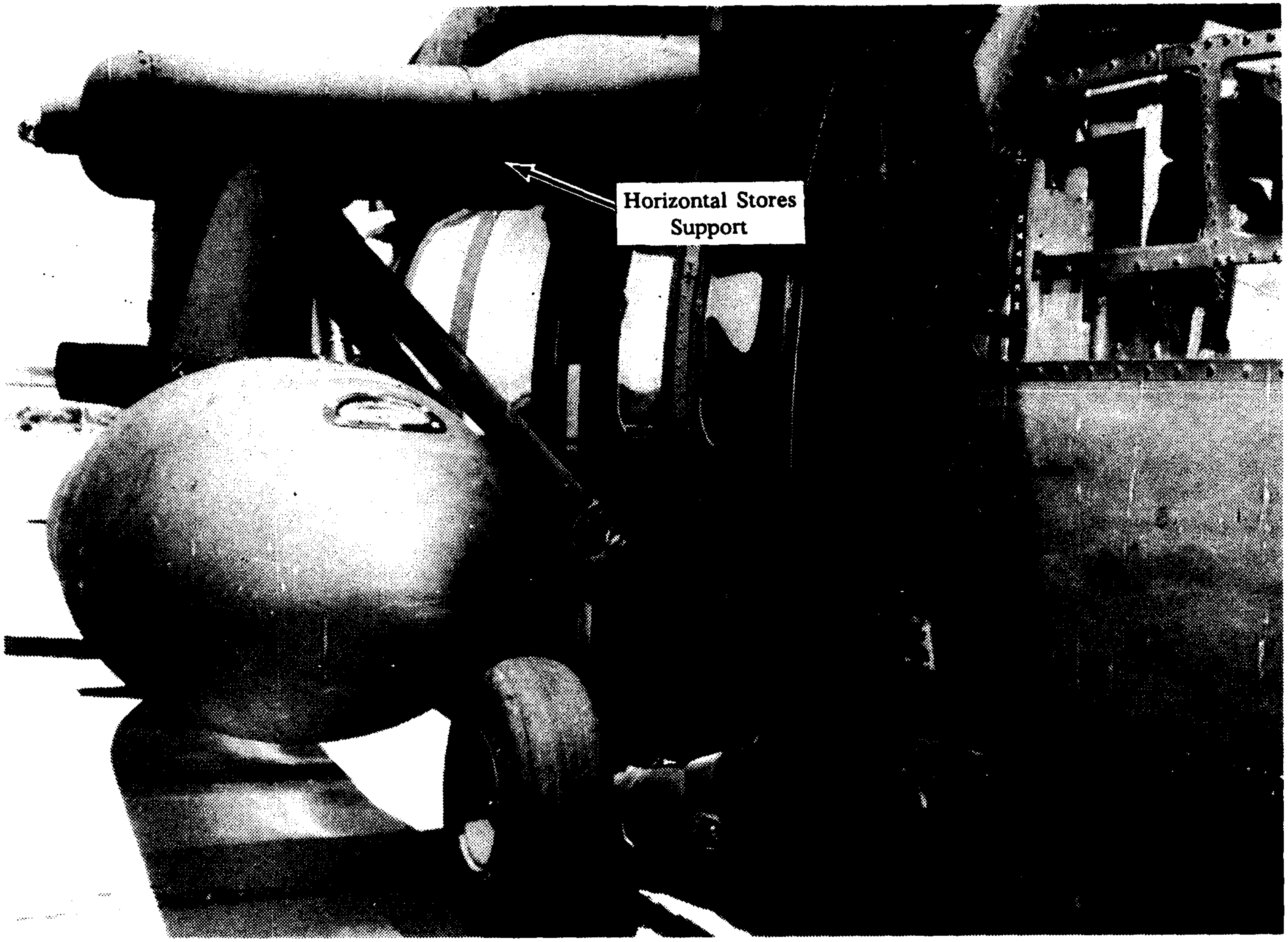


Figure B-3. Right Side, EFS with 230-Gallon Tank

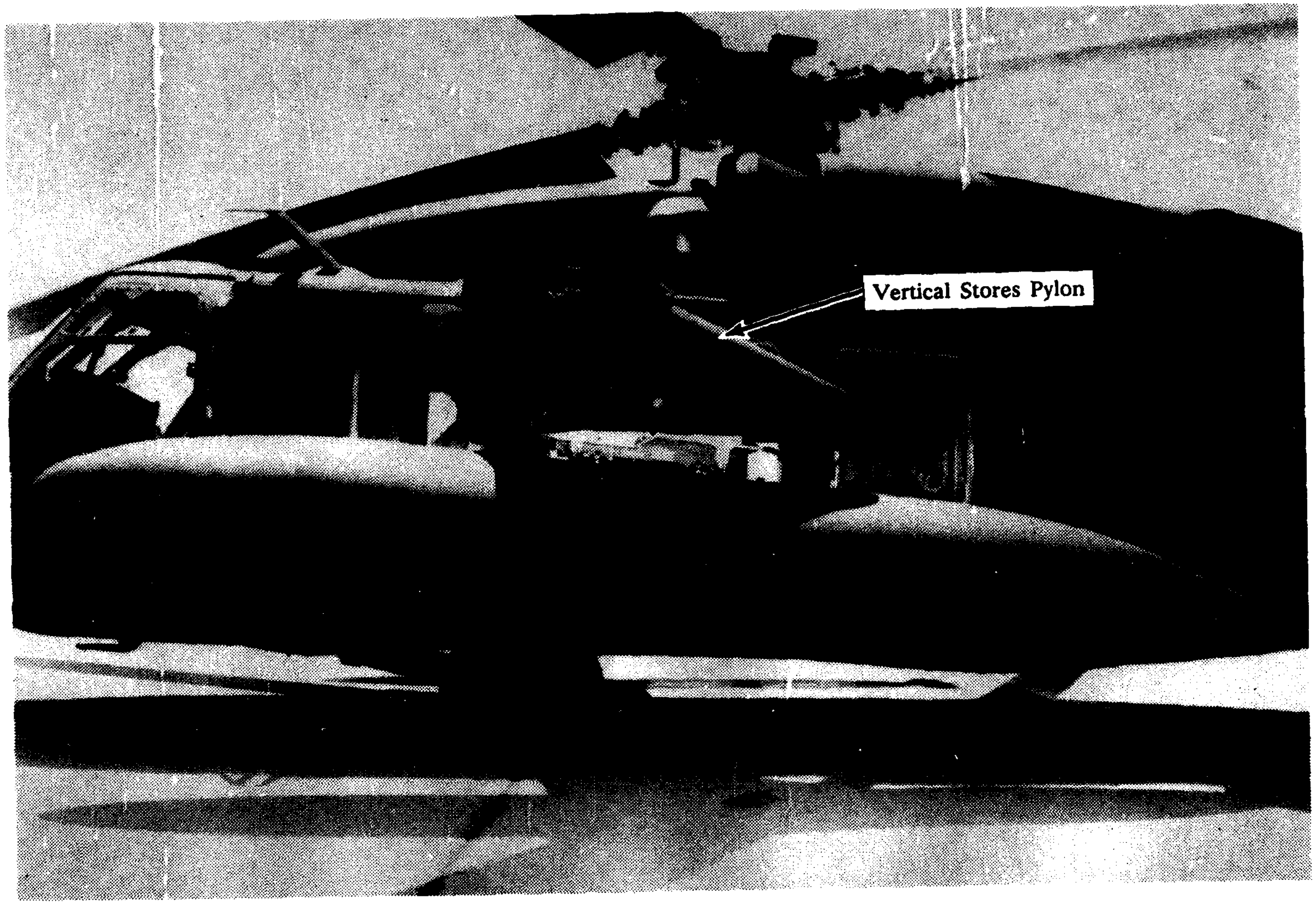


Figure B-4. Left Side, EFS with 230-Gallon Tank

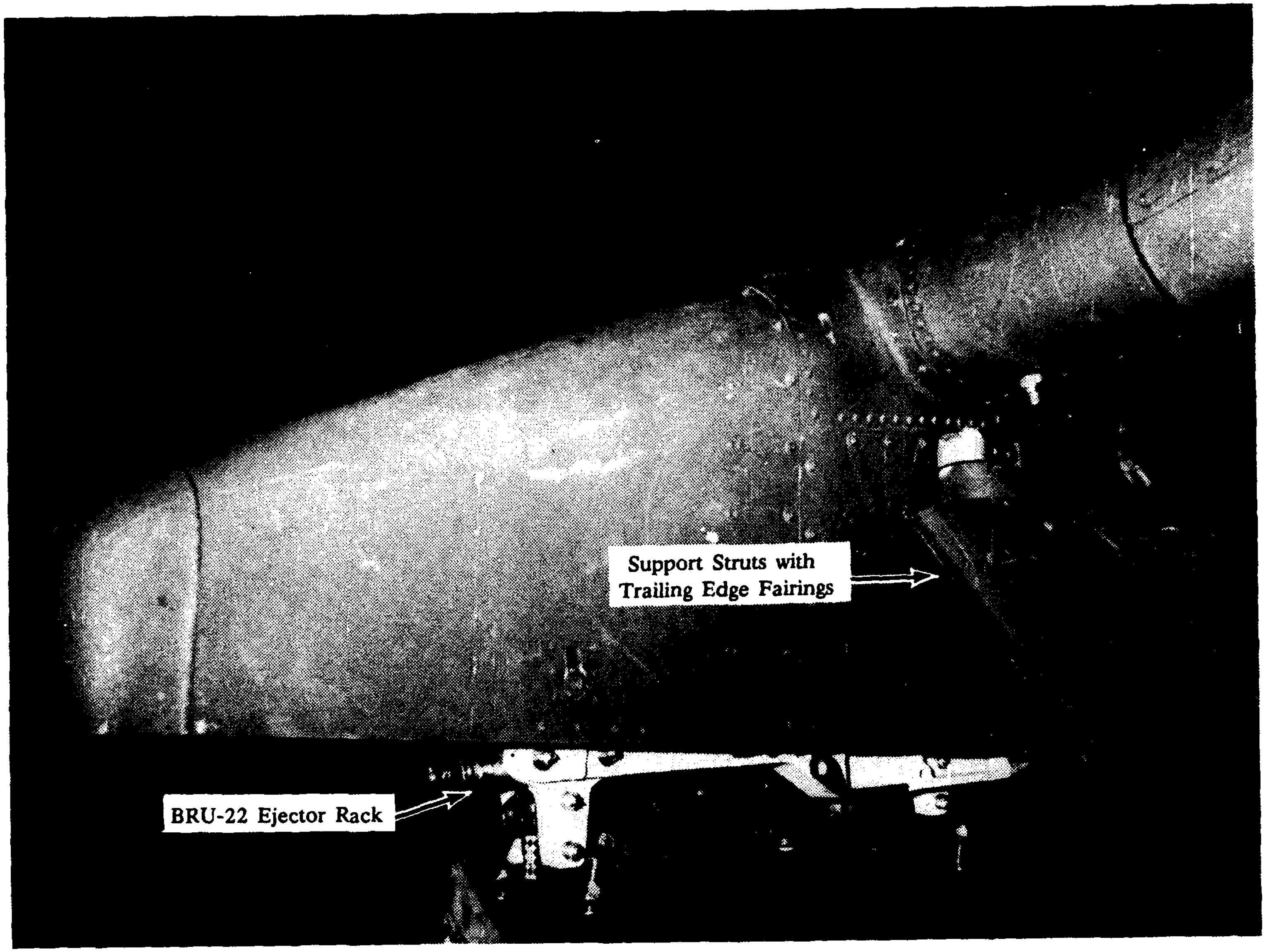


Figure B-5. Left Side Vertical Stores Pylon

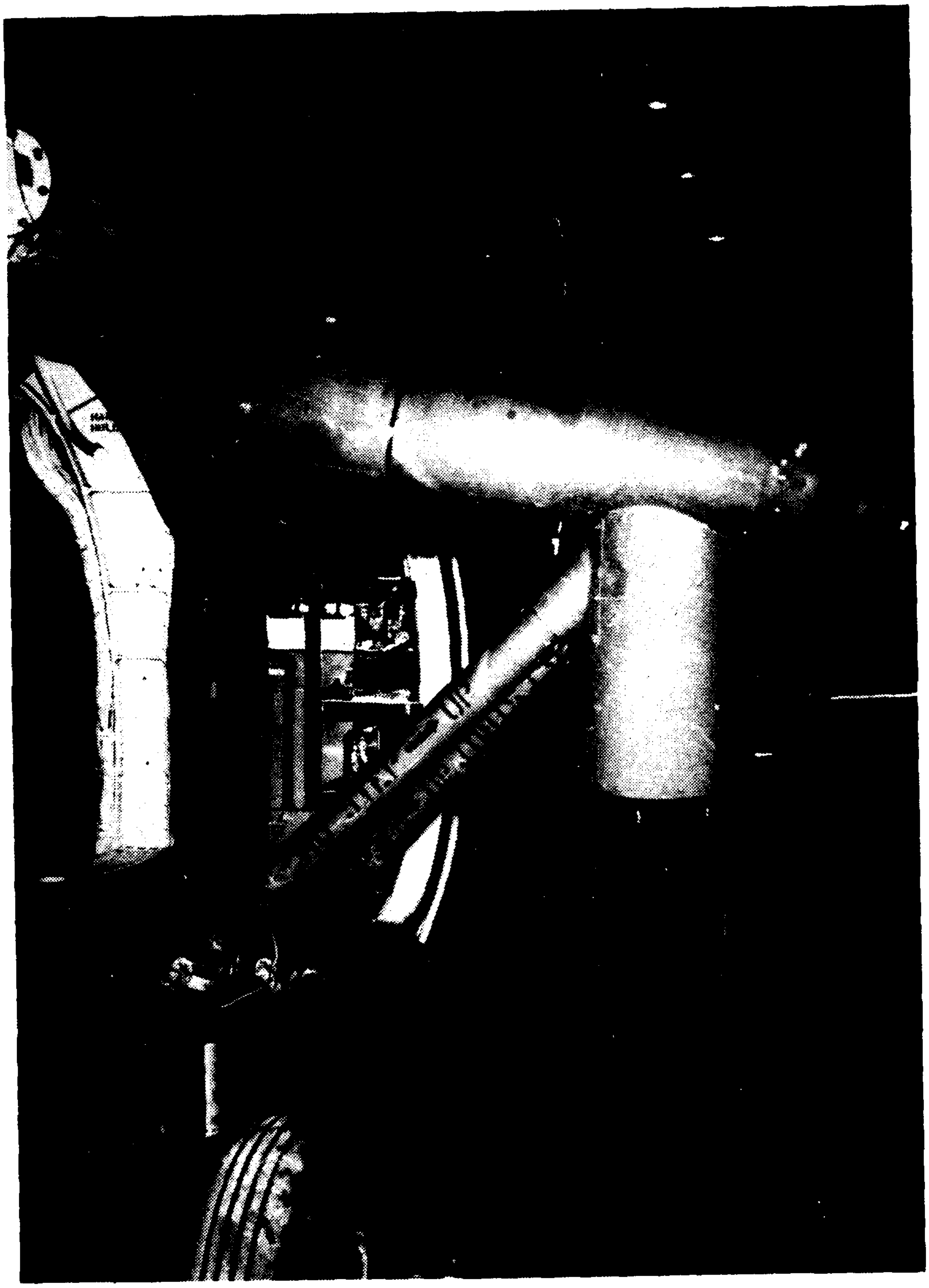


Figure B-6. Left Side, EFS Support Struts

APPENDIX C. INSTRUMENTATION

GENERAL

1. In addition to, or instead of standard aircraft instruments, sensitive calibrated instrumentation was installed in the test aircraft. The airborne data acquisition system was operated and maintained by the U.S. Army Aviation Engineering Flight Activity. The data acquisition system utilized pulse code modulation (PCM) encoding. Data was recorded by an on-board magnetic tape recording system. Equipment required only for specific tests is discussed in the section on special equipment.

2. A boom extending forward from the nose of the aircraft was installed. The boom incorporated angle-of-attack and angle-of-sideslip sensors, and a swiveling pitot-static tube. The tip of the swiveling pitot-static tube was 67 inches forward of the nose of the aircraft (fuselage station 97, buttline 25.7) and 7 inches below the forward avionics bay floor (waterline 208).

3. Data was obtained from instrumentation and displayed or recorded as indicated below:

Pilot Panel

Airspeed (boom system)
Altitude (boom system)
Airspeed*
Altitude*
Altitude (radar) *
Rate of climb*
Engine torque* **
Turbine gas temperature (T4.5)* **
Engine gas generator speed* **
Control positions
- Longitudinal
- Lateral
- Directional
- Collective

Stabilator position*
Angle of sideslip
Center of gravity (cg) normal acceleration
CG lateral acceleration
Tether cable angles
- Longitudinal
- Lateral

Tether cable tension

*Ship system
**Both engines

Copilot Panel

Airspeed*
Altitude*
Altitude (radar)*
Rate of climb*
Rotor speed*
Engine torque* **
Stabilator position*
Total air temperature*
Fuel remaining*
Ballast cart position
Event switch

Engineer Panel

Pressure altitude (boom system)
Engine fuel used**
Auxiliary power unit (APU) fuel used
Total air temperature
Rotor speed
Time code display
Run number
Event switch
Instrumentation controls

Digital (PCM) Parameters

Airspeed (boom system)
Altitude (boom system)
Airspeed (ship system)
Altitude (ship system)
Altitude (radar)
Total air temperature
Rotor speed
Engine torque**
Engine fuel flow**
Engine gas generator speed**
Engine power turbine speed**
Engine measured gas temperature**
Engine fuel used**
Engine fuel temperature (at fuel used transducer)**
APU fuel used
Tail rotor drive shaft torque
Stabilator position
Ballast cart position

*Ship system
**Both engines

- Tether cable angles
  - Longitudinal
  - Lateral
- Tether cable tension
- Control positions
  - Longitudinal
  - Lateral
  - Directional
  - Collective
- Stability Augmentation System output positions
  - Longitudinal
  - Lateral
  - Directional
- Control mixer input positions
  - Longitudinal
  - Lateral
  - Directional
- Primary servo positions
  - Lateral
  - Forward
  - Aft
- Angle of attack
- Angle of sideslip
- Aircraft attitudes
  - Pitch
  - Roll
- Heading
- Aircraft angular rates
  - Pitch
  - Roll
  - Yaw
- Linear accelerations
  - CG normal
  - CG lateral
  - CG longitudinal
- Vibrations
  - Pilot station (three-axis)
  - CG (three-axis)
  - Horizontal stabilator
    - Fuselage attachment
      - Lateral
      - Vertical
    - Tip (left and right)
      - Vertical
      - Longitudinal
- Time of day

Run number
Pilot event
Engineer event

AIRSPEED CALIBRATION

4. The boom and ship airspeed systems were calibrated in level flight using the trailing-bomb method. Data obtained during this evaluation were used to verify and supplement data from previous evaluations (ref 7, app A) conducted with the same aircraft and boom installation. The position error of the boom pitot-static system is presented in figure C-1. Appendix D contains a description of the method used to correct pitot-static measurements for the effects of thrust coefficient and position error.

SPECIAL EQUIPMENT

Weather Station

5. A portable weather station was used during the hover tests. The weather station equipment included an anemometer to measure wind speed and direction at selected heights up to 50 feet above ground level. A temperature gage and barometer were used to measure ambient temperature and atmospheric pressure.

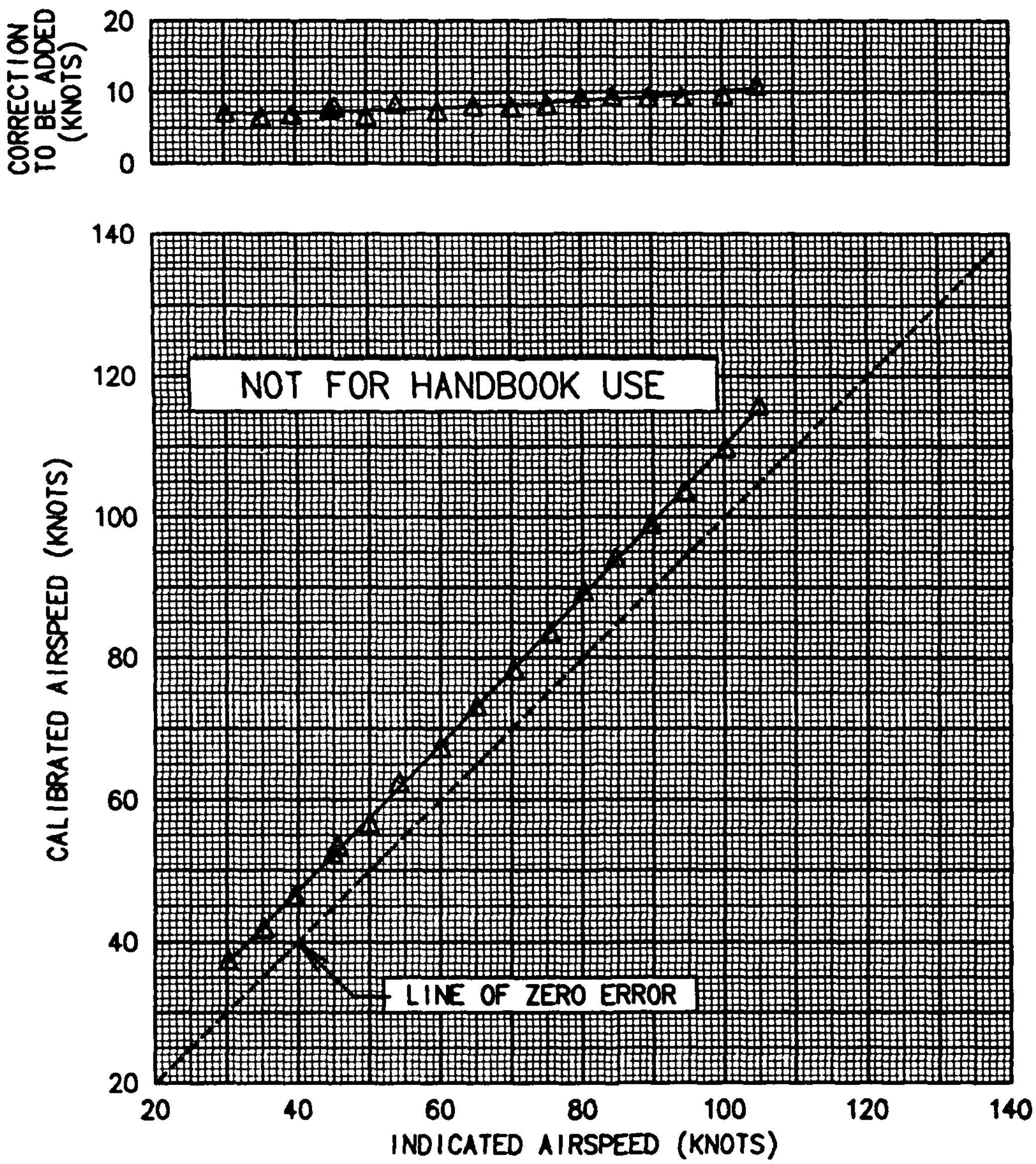
Load Cell

6. A calibrated load cell was incorporated with the ship's cargo hook to measure cable tension and accelerometers were used to measure longitudinal and lateral cable angles for the tethered hover tests. Indicators were installed in the cockpit to display cable tension and cable angles measured with reference to the ground.

FIGURE C-1
BOOM SYSTEM AIRSPEED CALIBRATION
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	TRIM FLIGHT CONDITION
17590	349.2	0.0	7520	11.0	256	LEVEL

NOTES: 1. TRAILING BOMB METHOD
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS



APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

AIRCRAFT RIGGING CHECK

1. A flight controls rigging check was conducted on the main and tail rotors to insure compliance with established limits. The stabilator control system was checked and found to conform to the modified production stabilator angle schedule.

AIRCRAFT WEIGHT AND BALANCE

2. The aircraft was weighed with the instrumentation installed with all fuel drained and with full oil prior to the start of testing. The aircraft was weighed in the External Fuel System (EFS) configuration with no tanks and the two 230-gallon tanks were weighed separately. The total empty weight of the test aircraft in the EFS, two 230-gallon tank configuration was calculated to be 12,838 pounds with the longitudinal center of gravity (cg) at fuselage station (FS) 355.1 and a mid lateral cg. The weights and cg's of the cargo and pilot/copilot doors and the gunner's windows were obtained from the weight and balance records. Fuel-level manometers calibrated during a previous test were used to determine fuel quantity before and after each test flight. A movable ballast system was used to maintain cg as fuel was consumed. The movable ballast system consisted of a cart (2000 pound capacity) that traveled on rails attached to the cabin floor, an electric screw jack that moved the cart through a range of 72.3 inches and a control system with a ballast cart position indicator.

PITOT-STATIC SYSTEM CALIBRATION

3. The test boom pitot-static system installed for this test was used to obtain airspeed, altitude, angle-of-sideslip and angle-of-attack data. A description of the test boom is contained in appendix C. Previous evaluations using this aircraft and boom installation have shown that the boom position error varies as a function of thrust coefficient (C_T). Airspeed calibration data from this evaluation were used to verify and supplement data obtained during previous evaluations (ref 7, app A). This comprehensive set of data was used during this evaluation to determine the boom-system position error. Position error was determined using a linear interpolation with four C_T's ranging from 0.0057 to 0.0090.

PERFORMANCE

General

4. Helicopter performance was generalized through the use of non-dimensional coefficients as follows using the 1976 U.S. Standard Atmosphere:

a. Coefficient of power (C_P):

$$C_P = SHP \frac{(550)}{\rho A (\Omega R)^3} \tag{1}$$

b. Coefficient of thrust (C_T):

$$C_T = \frac{GW + CABLE\ TENSION}{\rho A(\Omega R)^2} \tag{2}$$

c. Advance ratio (μ):

$$\mu = \frac{V_T\ (1.68781)}{\Omega R} \tag{3}$$

Where:

SHP = Engine output shaft horsepower (total for both engines)

ρ = Ambient air density (lb-sec²/ft⁴) $= \rho_o \left[\frac{\delta}{\theta}\right]$

$\rho_o = 0.002376892$ (lb-sec²/ft⁴)

δ = Pressure ratio $= \frac{P_a}{P_o}$

P_a = Ambient air pressure (in.-Hg)

P_o = 29.92125 in.-Hg

θ = Temperature ratio $= \frac{OAT + 273.15}{288.15}$

OAT = Ambient air temperature (degrees Celsius)
A = Main rotor disc area = 2262 ft²
Ω = Main rotor angular velocity (radians/sec)
R = Main rotor radius (ft) = 26.833 ft
GW = Gross weight (lb)

V_T = True airspeed (kt) $= \frac{V_E}{1.68781\sqrt{\rho/\rho_o}}$

1.68781 = Conversion factor (ft/sec-kt)

V_E = Equivalent airspeed (ft/sec) =

$$\left\{\frac{7(70.7262\ P_a)}{\rho_o}\left[\left(\frac{Q_c}{P_a}+1\right)^{2/7}-1\right]\right\}^{1/2}$$

70.7262 = Conversion factor (lb/ft²-in.-Hg)

Q_c = Dynamic pressure (in.-Hg)

At the normal operating rotor speed of 257.9 revolutions per minute (rpm) (100 percent), the following constants may be used to calculate C_P and C_T:

$\Omega R = 724.685$

$(\Omega R)^2 = 525,168.15$

$(\Omega R)^3 = 380,581,411.4$

5. The engine output shaft torque was determined by use of the engine torque sensor. The power turbine shaft contains a torque sensor tube that measures the total twist of the shaft. A concentric reference shaft is secured by a pin at the front end of the power turbine drive shaft and is free to rotate relative to the power turbine drive shaft at the rear end. The relative rotation is due to transmitted torque, and the resulting phase angle between the reference teeth on the two shafts is picked up by the torque sensor. The torque sensors for both engines were calibrated in a test cell by the engine manufacturer. The output from the engine torque sensors were recorded on the onboard data recording system. The output shp was determined from the engine's output shaft torque and rotational speed by the following equation.

$$SHP_t = \frac{Q\ (N_p)}{5252.113} \tag{4}$$

Where:

Q = Engine output shaft torque (ft-lb)
N_P = Engine output shaft rotational speed (rpm)
5252.113 = Conversion factor (ft-lb-rev/min-shp)

The output shp required was assumed to include 13 horsepower for daylight operations of the aircraft electrical system, but was corrected for the effects of test instrumentation electrical load. A power loss of 1.82 horsepower was determined for electrical operation of the instrumentation. Reductions in power required were made for the effect of external instrumentation drag. This was determined by the following equation.

$$SHP_{instr\ drag} = \frac{F_e\ (\rho/\rho_O)(V_T)^3}{96254} \tag{5}$$

Where:

F_e = 0.833 ft^2 (estimated)
96254 = Conversion factor (ft^2-kt^3/SHP)

The nominal fuel temperature of 50 degrees Celsius was used in the determination of engine fuel consumption and was based on actual measurements.

Hover Performance

6. Hover performance was obtained by the tethered hover technique. Limited free-flight hover data were obtained to verify the tethered hover data. All hover tests were conducted in winds of less than 3 knots. Tethered hover consists of restraining the helicopter to the ground by a cable in series with a load cell. An increase in cable tension, measured by the load cell, is equivalent to an increase in gross weight. Free-flight hover tests consisted of stabilizing the helicopter at a desired height using the radar altimeter as a height reference. All hovering data were reduced to nondimensional parameters of C_P and C_T using equations 1 and 2, and grouped according to wheel height. The hover capability at standard-day, sea-level conditions was determined by using equations 1 and 2, the main transmission limit power of 2828 shp and the fairings presented with the data.

Level Flight Performance

General:

7. Each speed power was flown in ball-centered flight by reference to a high-resolution lateral accelerometer at a predetermined C_T and a referred rotor speed ($N_R/\sqrt{\theta}$) of approximately 258 rpm. To maintain the ratio of gross weight to pressure ratio constant, altitude was increased as fuel was consumed. To maintain $N_R/\sqrt{\theta}$ constant, rotor speed was decreased as temperature decreased. Power corrections for rate-of-climb and acceleration were determined (when applicable) by the following equations:

$$SHP_{r/c} = -\frac{(R/C_{TL})(GW)}{33,000(K_P)} \tag{6}$$

$$SHP_{accel} = -1.6098 \times 10^{-4} \left(\frac{\Delta V}{\Delta t}\right)(V_T)(GW) \tag{7}$$

Where:

R/C_{TL} = Tapeline rate of climb (ft/min) = $\left(\frac{\Delta H_P}{\Delta t}\right)\left(\frac{OAT + 273.15}{OAT_s + 273.15}\right)$

$\frac{\Delta H_P}{\Delta t}$ = Change in pressure altitude per unit time (ft/min)

OAT_s = Standard ambient temperature at mean pressure altitude where $\frac{\Delta H_P}{\Delta t}$ was measured (degrees Celsius)

$K_P = 0.76$

1.6098×10^{-4} = Conversion factor (shp-sec/kt^2-lb)

$\frac{\Delta V}{\Delta t}$ = Change in airspeed per unit time (kt/sec)

Power required for level flight at the test conditions was corrected using the following equation:

$$SHP_{corr} = SHP_t + SHP_{r/c} + SHP_{accel} - SHP_{instr\ drag} - 1.82 \tag{8}$$

8. Level flight data were normalized to average test day conditions by the following equations:

$$SHP_n = SHP_{corr} \frac{(\delta_{avg}\sqrt{\theta_{avg}})\left[\frac{N_R}{\sqrt{\theta}}\right]^3_{avg}}{(\delta_t\sqrt{\theta_t})\left[\frac{N_R}{\sqrt{\theta}}\right]^3_t} \tag{9}$$

$$V_{T_n} = V_{T_t}\frac{\sqrt{\theta_{avg}}\left[\frac{N_R}{\sqrt{\theta}}\right]_{avg}}{\sqrt{\theta_t}\left[\frac{N_R}{\sqrt{\theta}}\right]_t} \tag{10}$$

Where:

N_R = Main rotor speed (rpm)
subscript t = Individual test point
subscript avg = Average for all test points
subscript n = normalized

9. Level flight performance was determined by using equations 1 through 3, rewritten in the following form:

$$C_P = \frac{SHP(478935.3)}{\delta\sqrt{\theta}\left[\frac{N_R}{\sqrt{\theta}}\right]^3 \varrho_o A R^3} \tag{11}$$

$$C_T = \frac{GW(91.19)}{\delta\left[\frac{N_R}{\sqrt{\theta}}\right]^2 \varrho_o A R^2} \tag{12}$$

$$\mu = \frac{V_T(16.12)}{R\sqrt{\theta}\ \frac{N_R}{\sqrt{\theta}}} \tag{13}$$

Where:

478935.3 = Conversion factor (ft-lb-sec^2-rev^3/min^3-shp)
91.19 = Conversion factor (sec^2-rev^2/min^2)
16.12 = Conversion factor (ft-rev/min-kt)

10. Data analysis was accomplished by comparing C_P versus μ with the baseline data (ref 8) at the average C_T and $N_R/\sqrt{\theta}$ for each test. The difference in C_P between each individual point and the baseline data was converted to ΔF_e using a form of equation 5 and a curve was faired through these data for each configuration. The resulting curves represent a summary of change in drag between the baseline and the various configurations tested.

11. The specific range (SR) data were derived from the test level flight power required and fuel flow (W_{F_t}). Selected level flight performance shp and fuel flow data for each engine were referred as follows:

$$SHP_{REF} = \frac{SHP_{corr}}{\delta_t \theta_t^{\ 0.5}} \tag{14}$$

$$W_{F_{REF}} = \frac{W_{F_t}}{\delta_t \theta_t^{\,0.55}} \qquad (15)$$

A curve fit was subsequently applied to this referred data and was used as the basis to normalize W_{F_t} to average test day fuel flow using the following equation:

$$W_{F_n} = W_{F_t} + \Delta W_F \qquad (16)$$

Where:

ΔW_F = Change in fuel flow between SHP_{corr} and SHP_n

The following equation was used for determination of SR:

$$SR = \frac{V_{T_n}}{W_{F_n}} \qquad (17)$$

HANDLING QUALITIES

12. Handling qualities of the UH-60A EFS were evaluated using conventional test techniques as described in the Naval Air Test Center Flight Test Manual, FTM No. 105 (ref 11). A Handling Qualities Rating Scale (fig. D-1) was used to augment pilot comments about aircraft handling qualities.

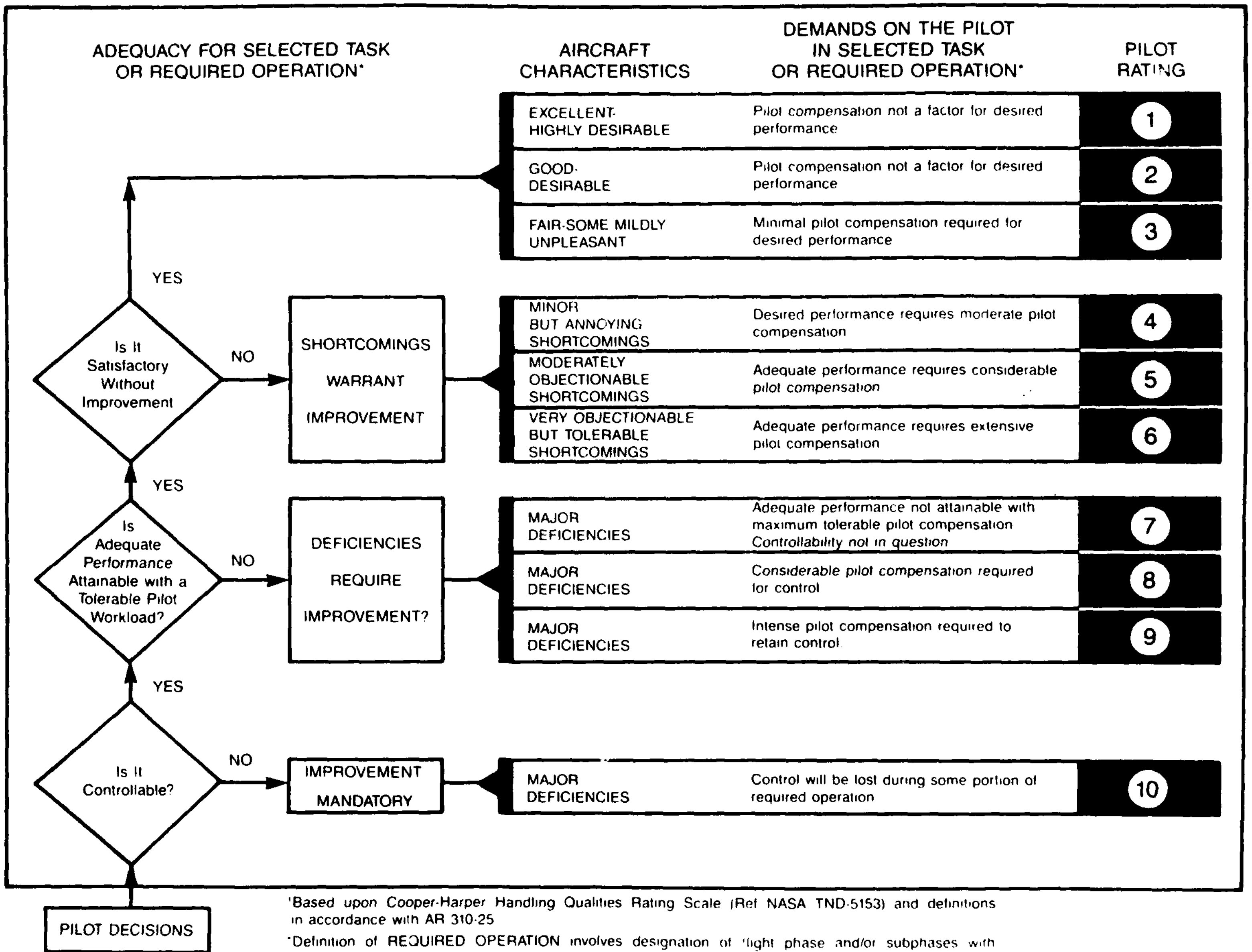
VIBRATION

13. Vibration data were analyzed using a CPSI MAP 200 array processor. The analyzer converted the data from the time domain (acceleration as a function of time) to the frequency domain (acceleration as a function of frequency). The data were analyzed using a frequency range from zero to 100 Hertz (Hz) and frequency resolution of 0.3 Hz. In order to minimize random variation in acceleration amplitude, the data were averaged over a 15-second time interval using ensemble averaging.

DEFINITION

Shortcoming

14. An imperfection or malfunction occurring during the life cycle of equipment which must be reported and which should be corrected to increase efficiency and to render the equipment completely serviceable. It will not cause an immediate breakdown, jeopardize safe operation, or materially reduce the usability of the materiel or end product.



*Based upon Cooper-Harper Handling Qualities Rating Scale (Ref NASA TND-5153) and definitions in accordance with AR 310-25

*Definition of REQUIRED OPERATION involves designation of flight phase and/or subphases with accompanying conditions

Figure D-1. Handling Qualities Rating Scale

APPENDIX E. TEST DATA

INDEX

FIGURE E-1
NONDIMENSIONAL HOVER PERFORMANCE
UH-60A USA S/N 82-23748

WHEEL HEIGHT = 10 FT

SYMBOL	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
○	2720	15.5	245
◇	2680	15.0	259
△	2690	15.0	263

NOTES:
1. TEST CONDUCTED WITH THE AIRCRAFT TETHERED TO THE GROUND
2. WHEEL HEIGHT MEASURED FROM BOTTOM OF LEFT MAIN WHEEL
3. VERTICAL DISTANCE FROM BOTTOM OF MAIN WHEELS TO CENTER OF MAIN ROTOR HUB = 12 FT
4. WINDS LESS THAN THREE KNOTS
5. DASHED LINE DENOTES FAIRING FROM AEFA PROJECT REPORT NO. 86-12 (NORMAL UTILITY CONFIGURATION)
6. SHADED SYMBOL DENOTES FREE FLIGHT HOVER TECHNIQUE
7. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

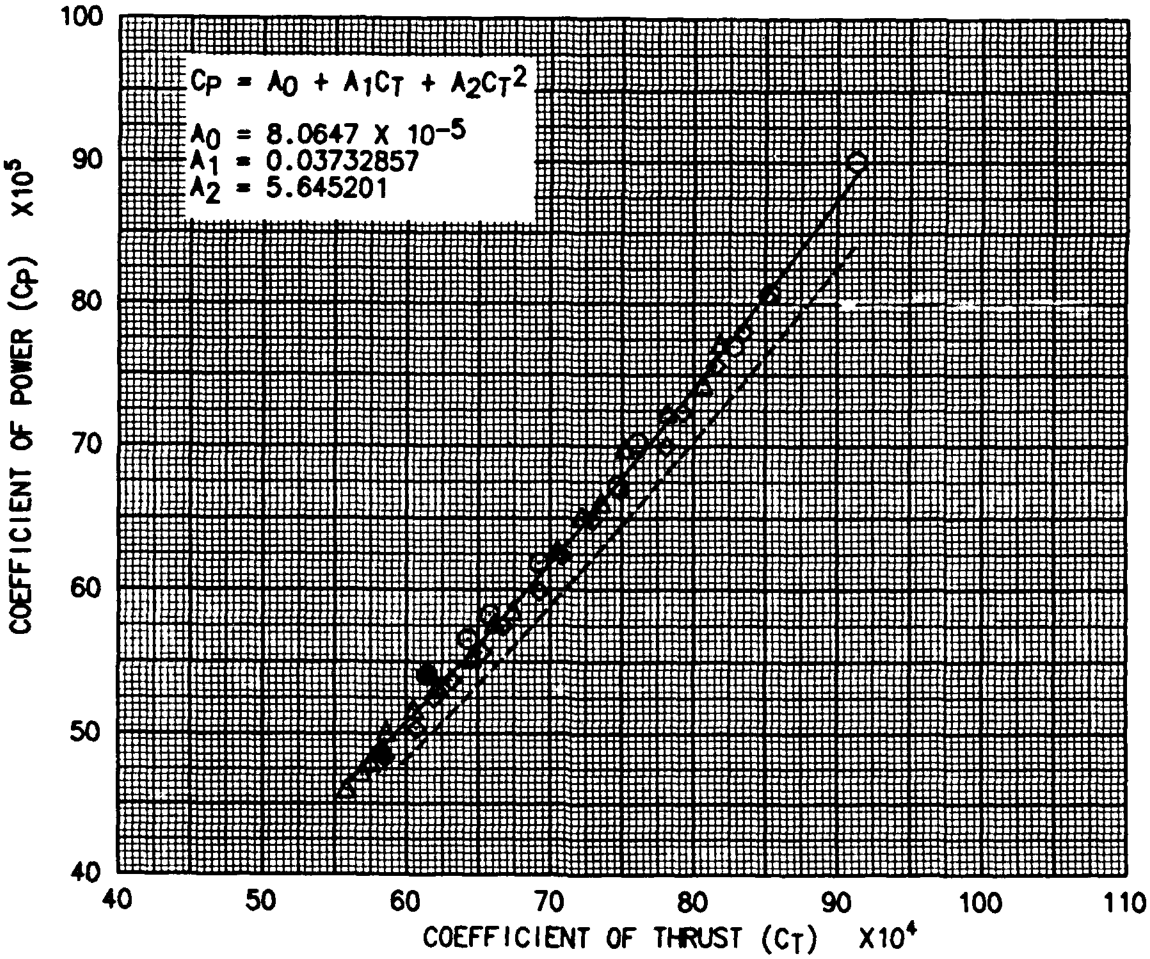


FIGURE E-2
NONDIMENSIONAL HOVER PERFORMANCE
UH-60A USA S/N 82-23748

WHEEL HEIGHT = 100 FT

SYMBOL	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
⊙	2870	16.0	245
◇	2990	17.0	260
△	2840	15.5	263

NOTES:
1. TEST CONDUCTED WITH THE AIRCRAFT TETHERED TO THE GROUND
2. WHEEL HEIGHT MEASURED FROM BOTTOM OF LEFT MAIN WHEEL
3. VERTICAL DISTANCE FROM BOTTOM OF MAIN WHEELS TO CENTER OF MAIN ROTOR HUB = 12 FT
4. WINDS LESS THAN THREE KNOTS
5. DASHED LINE DENOTES FAIRING FROM AEFA PROJECT REPORT NO. 83-24 (NORMAL UTILITY CONFIGURATION)
6. SHADED SYMBOL DENOTES FREE FLIGHT HOVER TECHNIQUE
7. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

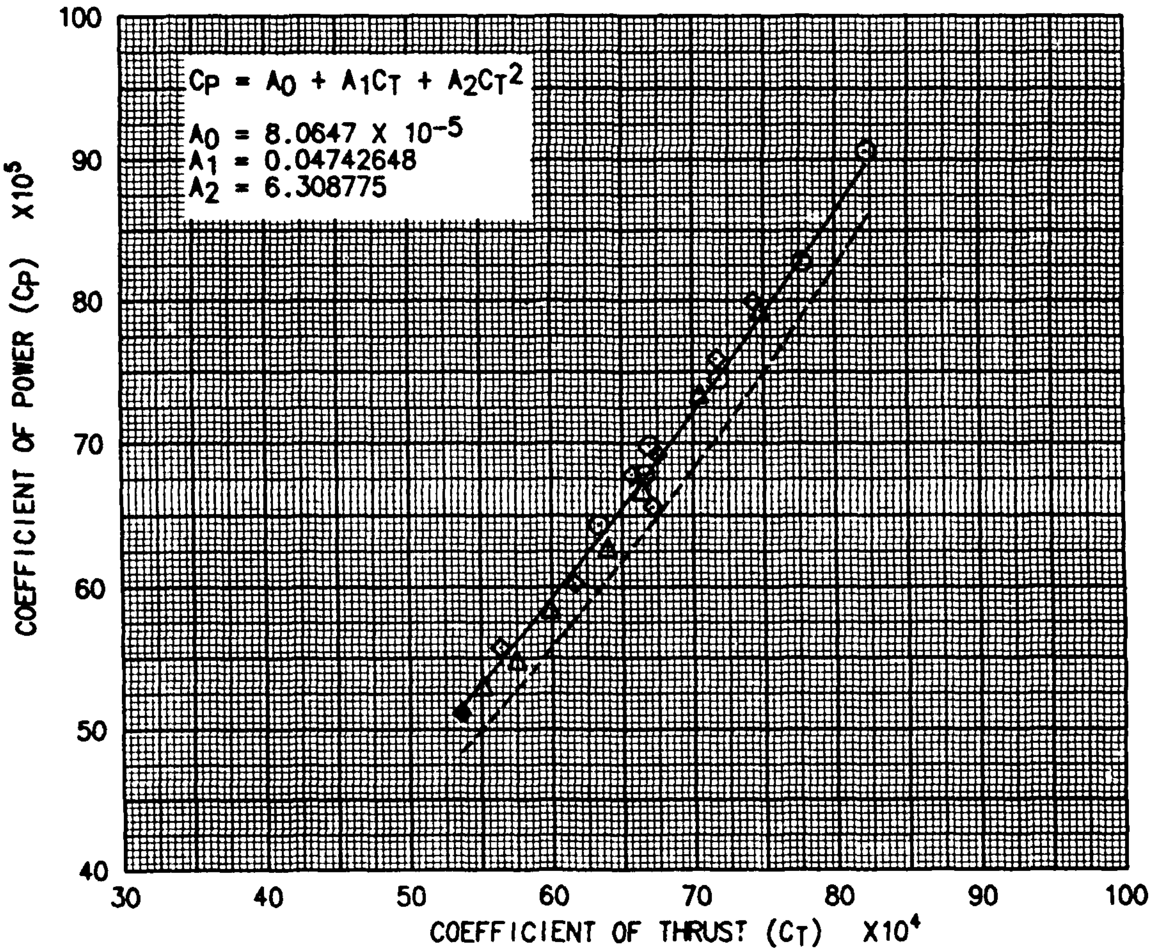


FIGURE E-3
SUMMARY OF DRAG CHANGE FOR THE EXTERNAL FUEL SYSTEM
UH-60A USA S/N 82-23748

NOTES:
1. BALL CENTERED TRIM CONDITION
2. AVERAGE LONGITUDINAL C.G. LOCATION AT FS 347.5
3. MID LATERAL C.G.
4. BASELINE DATA FROM AEFA PROJECT 83-24, FIGURES E-23 THRU E-25
5. FAIRINGS DERIVED FROM FIGURES E-7 THRU E-16

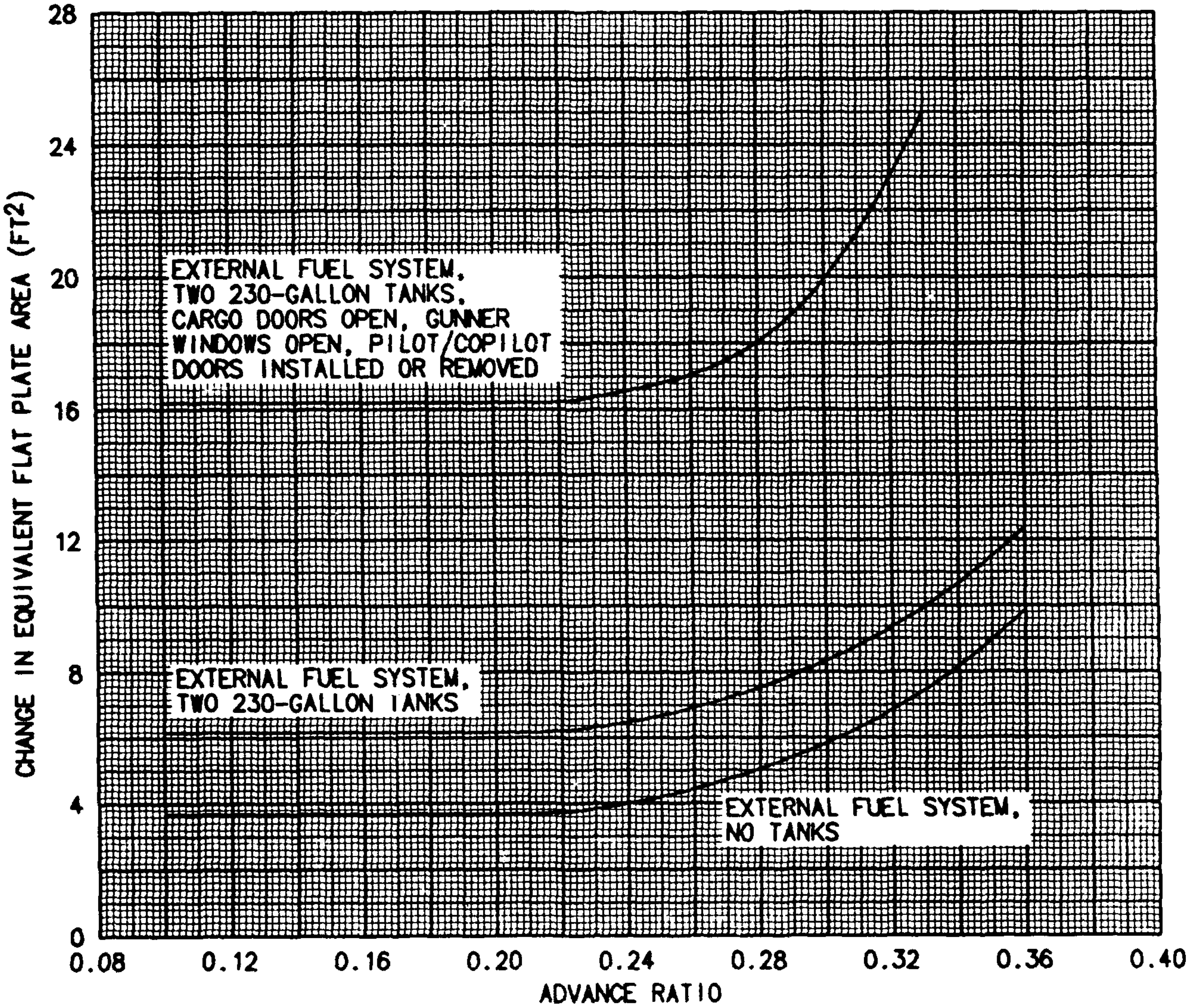


FIGURE E-4
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

NOTES:
1. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS
2. REFERRED ROTOR SPEED = 258.1 RPM
3. BALL CENTERED TRIM CONDITION
4. AVERAGE LONGITUDINAL C.G. LOCATION AT FS 347.5
5. MID LATERAL C.G.
6. POINTS DERIVED FROM FIGURES E-7 THRU E-9

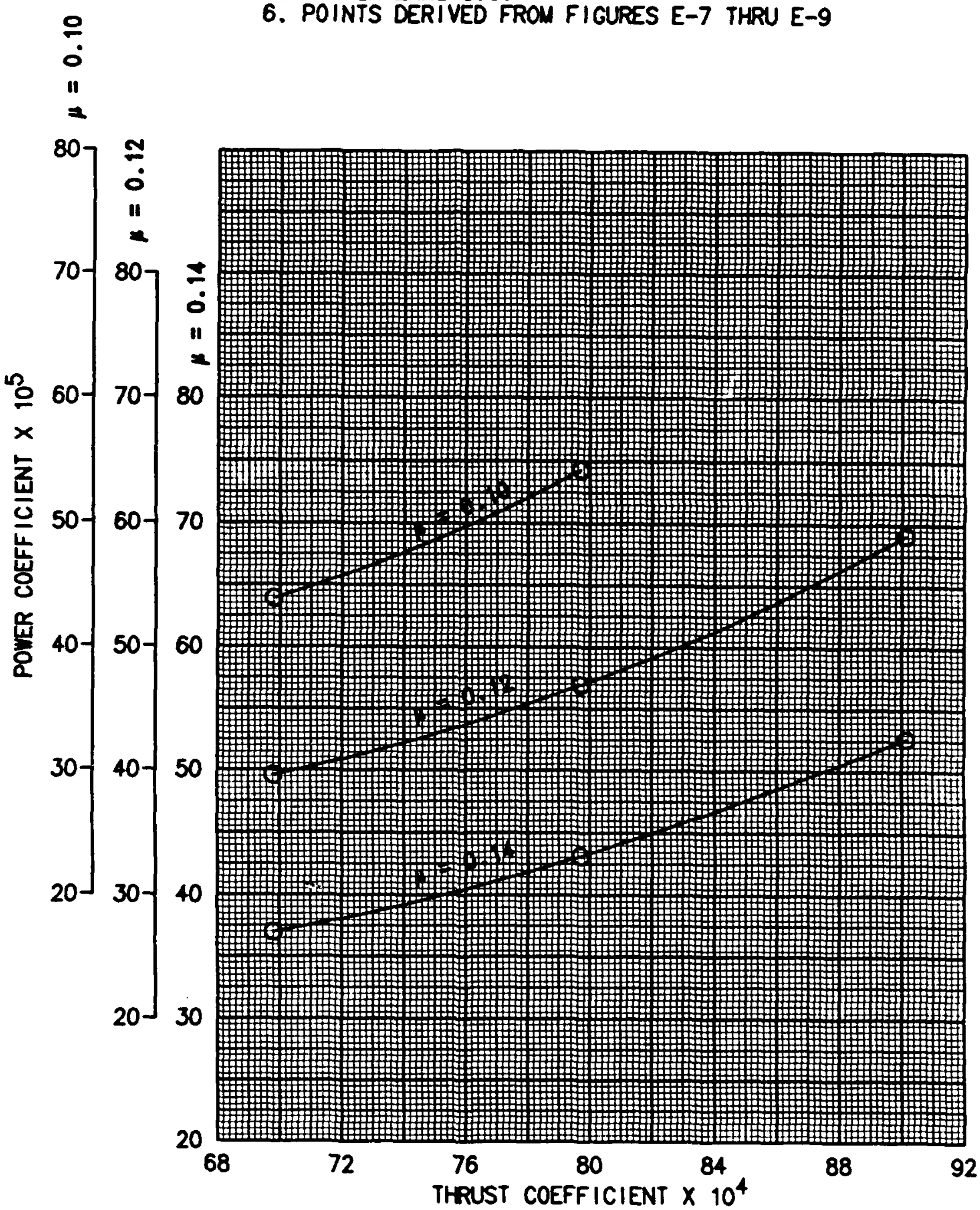


FIGURE E-5
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

NOTES: 1. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS
2. REFERRED ROTOR SPEED = 258.1 RPM
3. BALL CENTERED TRIM CONDITION
4. AVERAGE LONGITUDINAL C.G. LOCATION AT FS 347.5
5. MID LATERAL C.G.
6. POINTS DERIVED FROM FIGURES E-7 THRU E-9

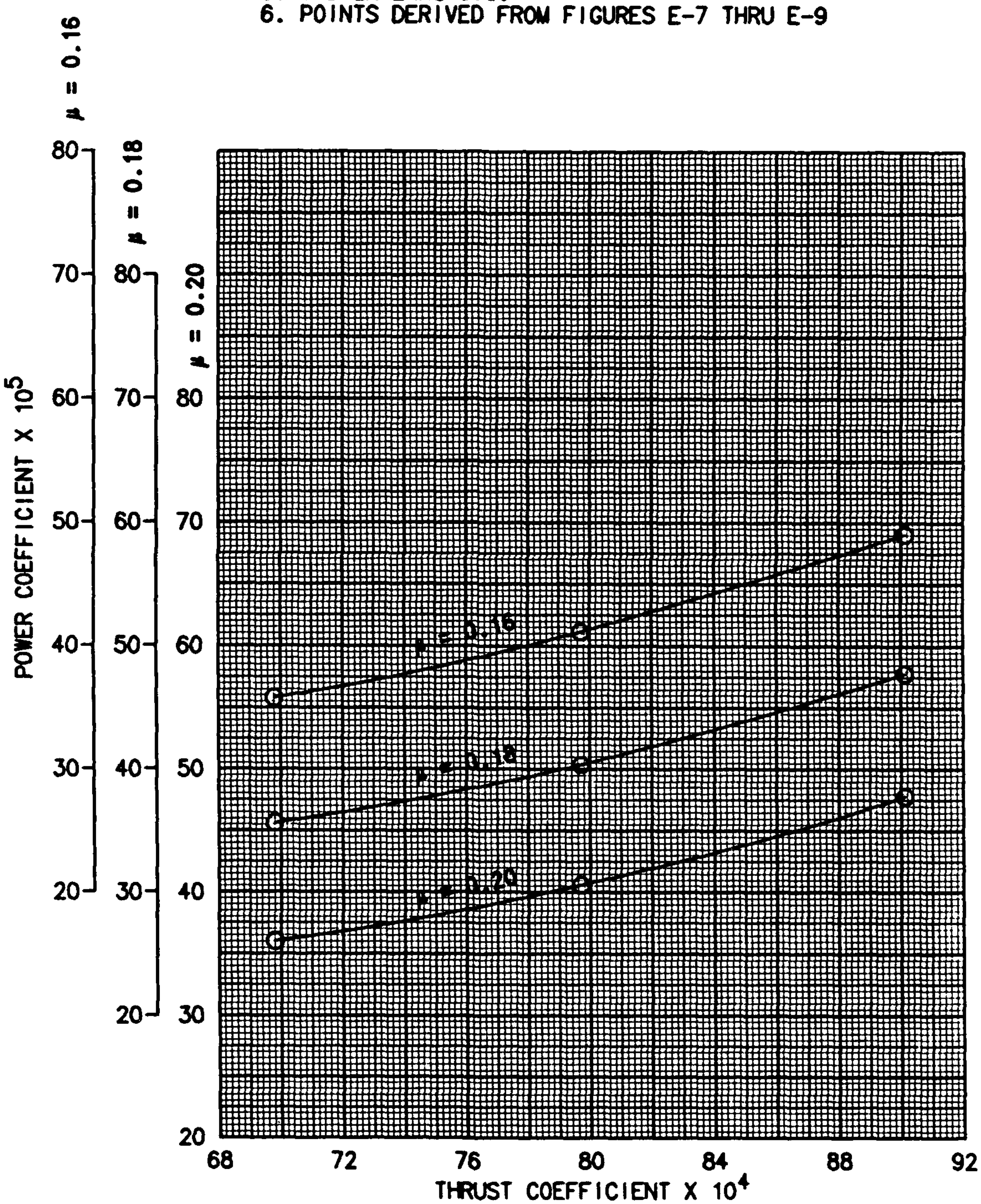


FIGURE E-6
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

NOTES:
1. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS
2. REFERRED ROTOR SPEED = 258.1 RPM
3. BALL CENTERED TRIM CONDITION
4. AVERAGE LONGITUDINAL C.G. LOCATION AT FS 347.5
5. MID LATERAL C.G.
6. POINTS DERIVED FROM FIGURES E-7 THRU E-9

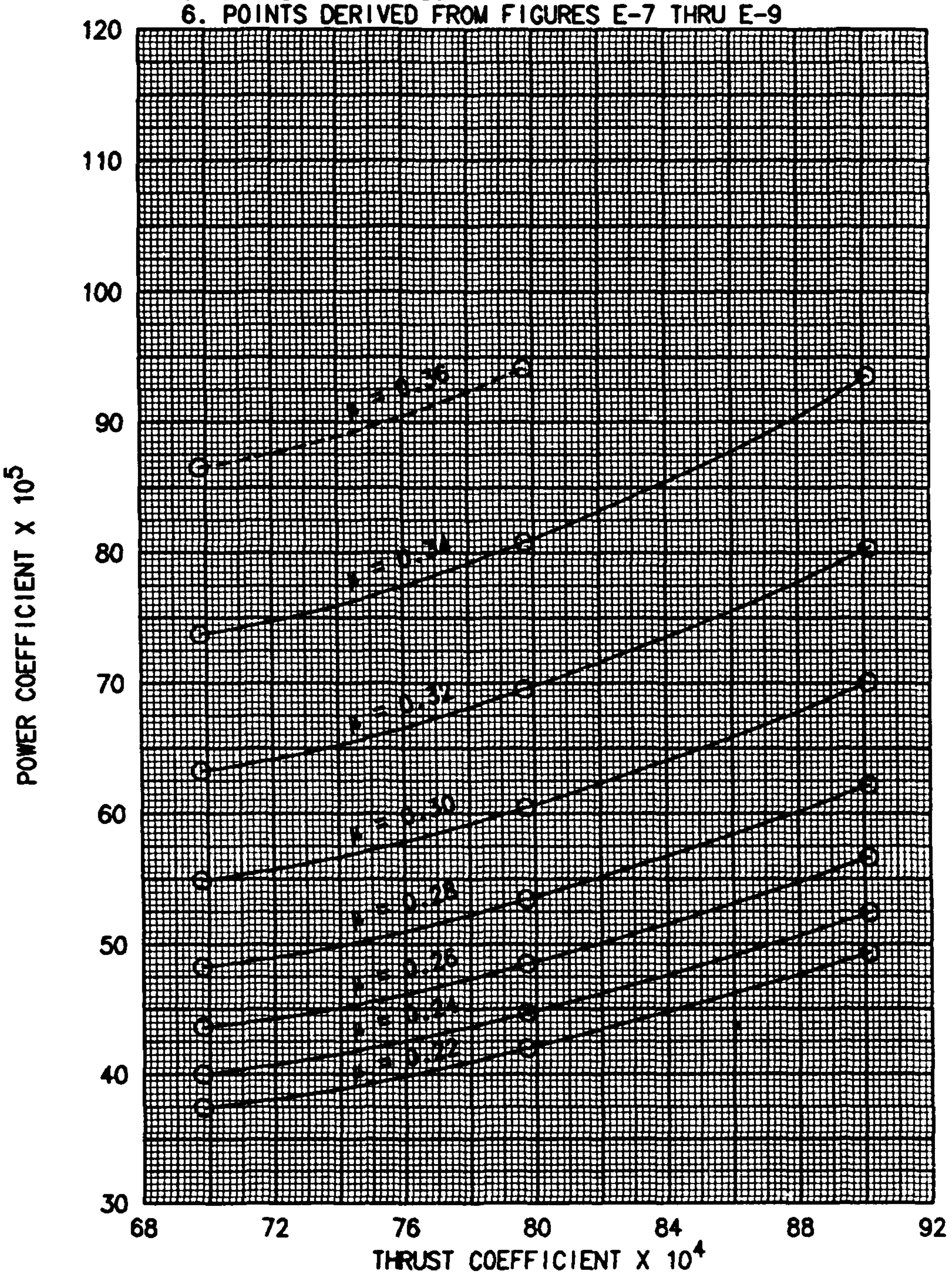


FIGURE E-7
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
17390	348.1(FWD)	0.0	4690	18.5	258.2	.006980

NOTES: 1. BALL CENTERED TRIM CONDITION
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

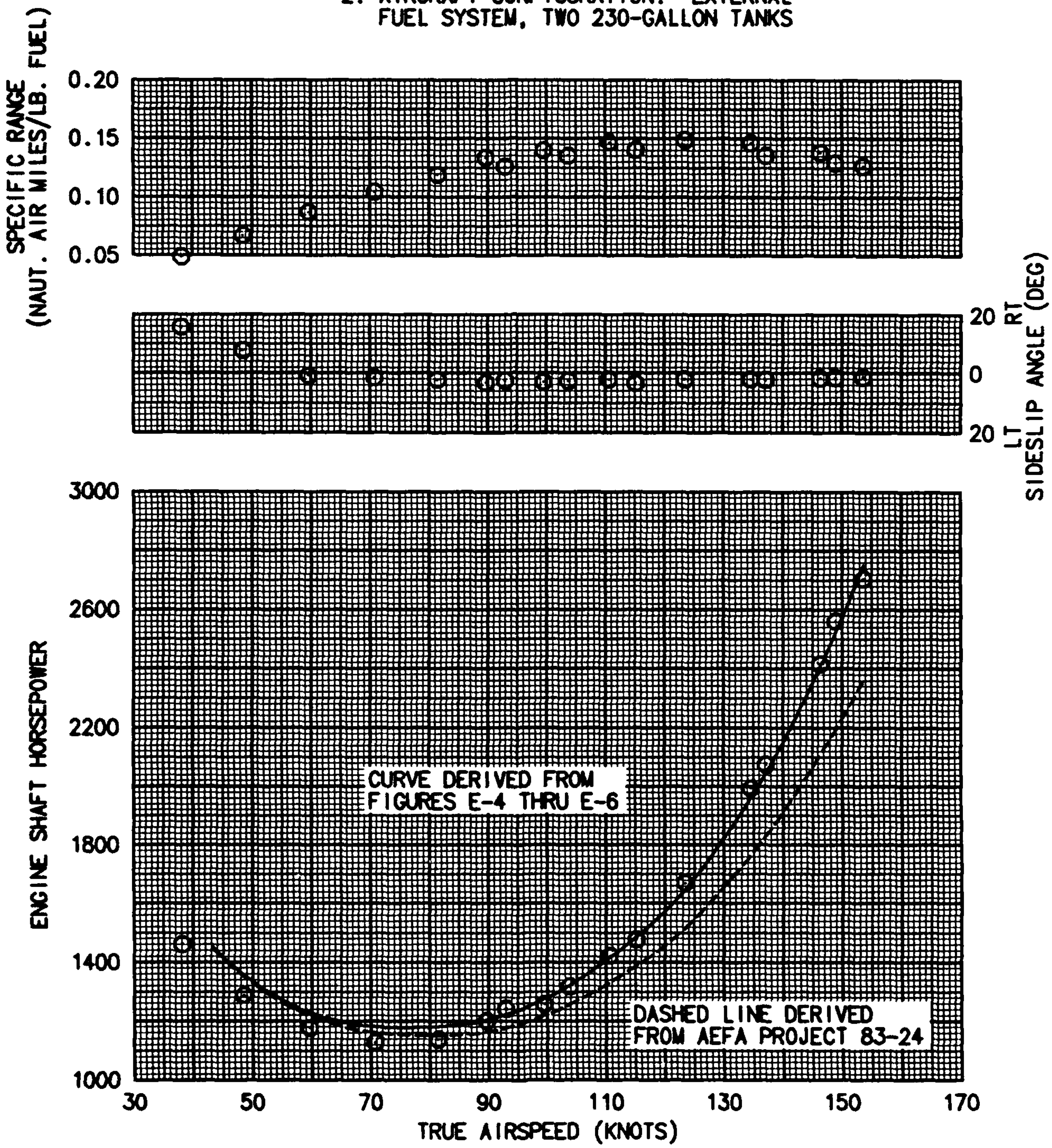


FIGURE E-8
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
17540	348.0(FWD)	0.0	7920	11.0	258.3	.007970

NOTES: 1. BALL CENTERED TRIM CONDITION
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

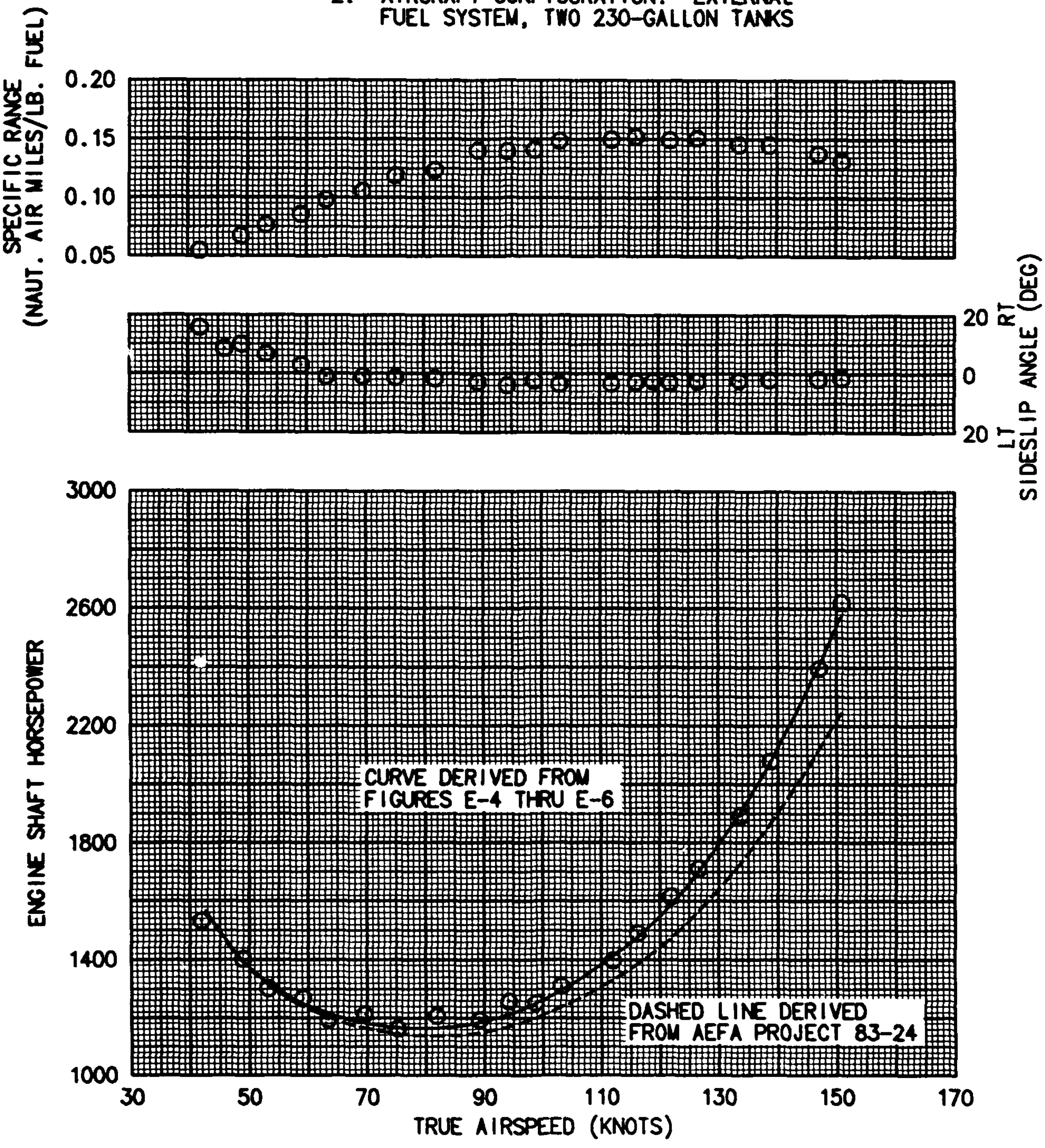


FIGURE E-9
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18630	347.2(FWD)	0.0	9010	4.0	257.8	.009013

NOTES: 1. BALL CENTERED TRIM CONDITION
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

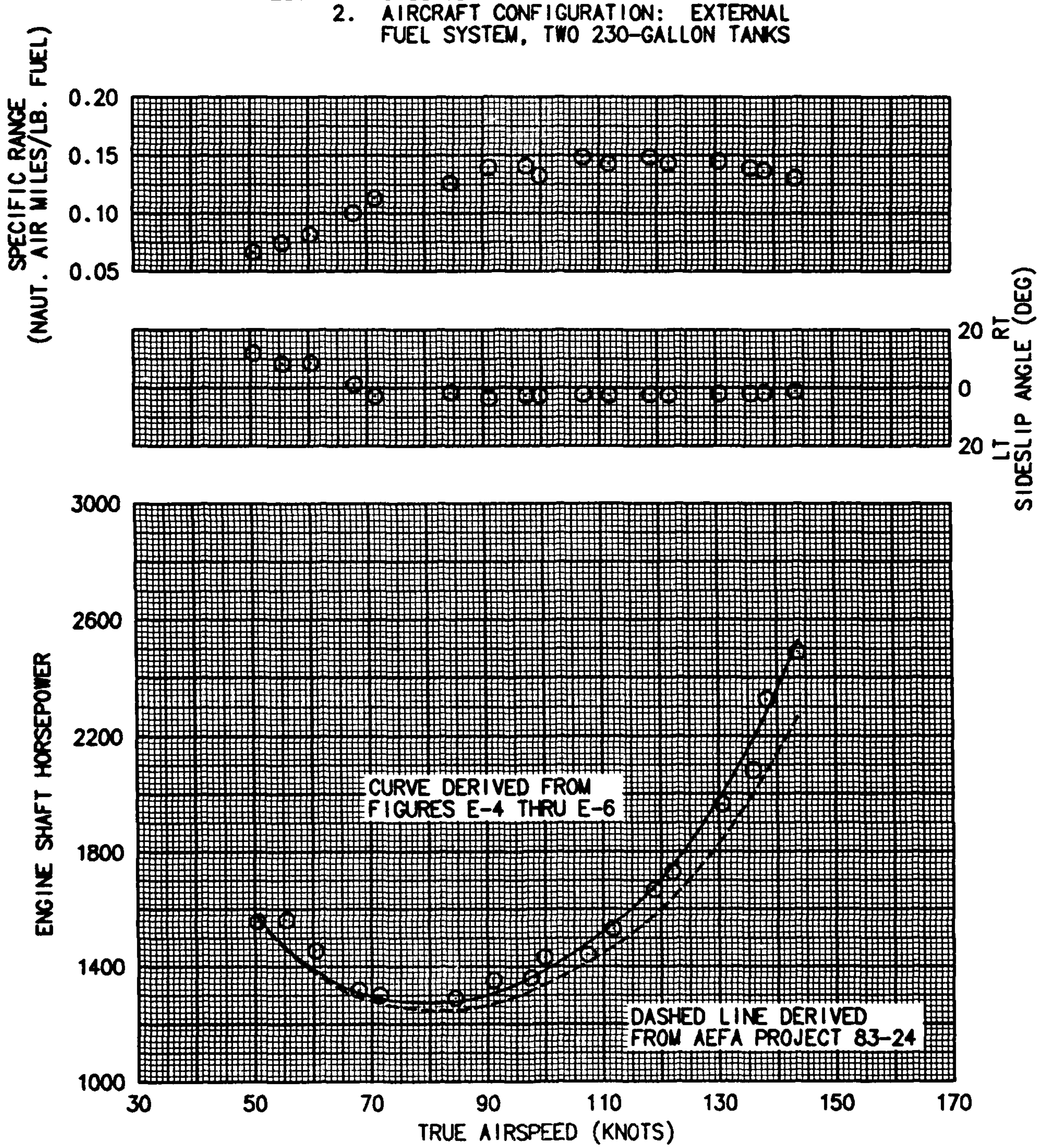


FIGURE E-10
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
17250	347.7(FWD)	0.0	5040	19.0	258.4	.006974

NOTES: 1. BALL CENTERED TRIM CONDITION
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, NO TANKS

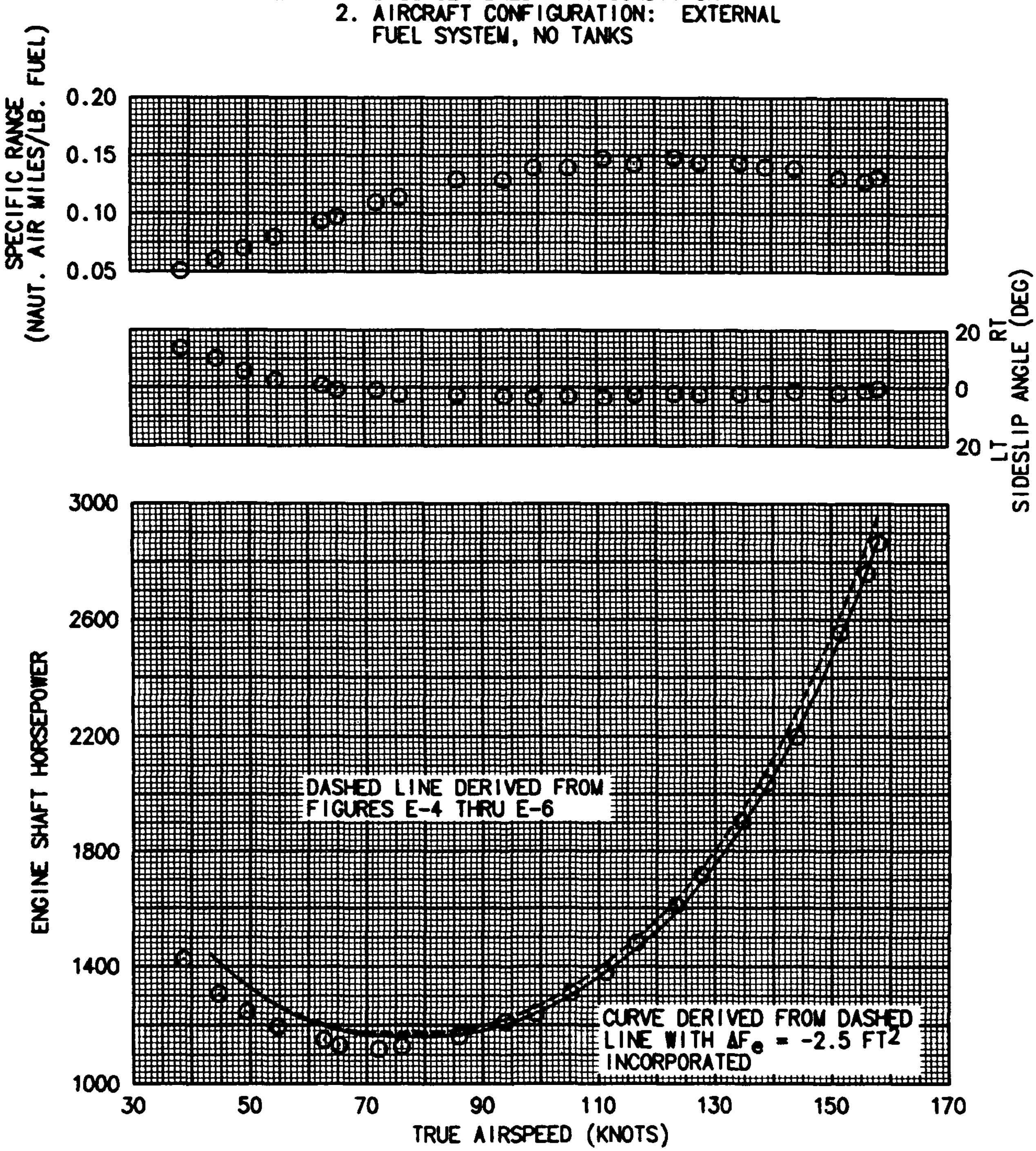


FIGURE E-11
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18170	347.6(FWD)	0.0	7040	13.0	258.3	.007979

NOTES: 1. BALL CENTERED TRIM CONDITION
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, NO TANKS

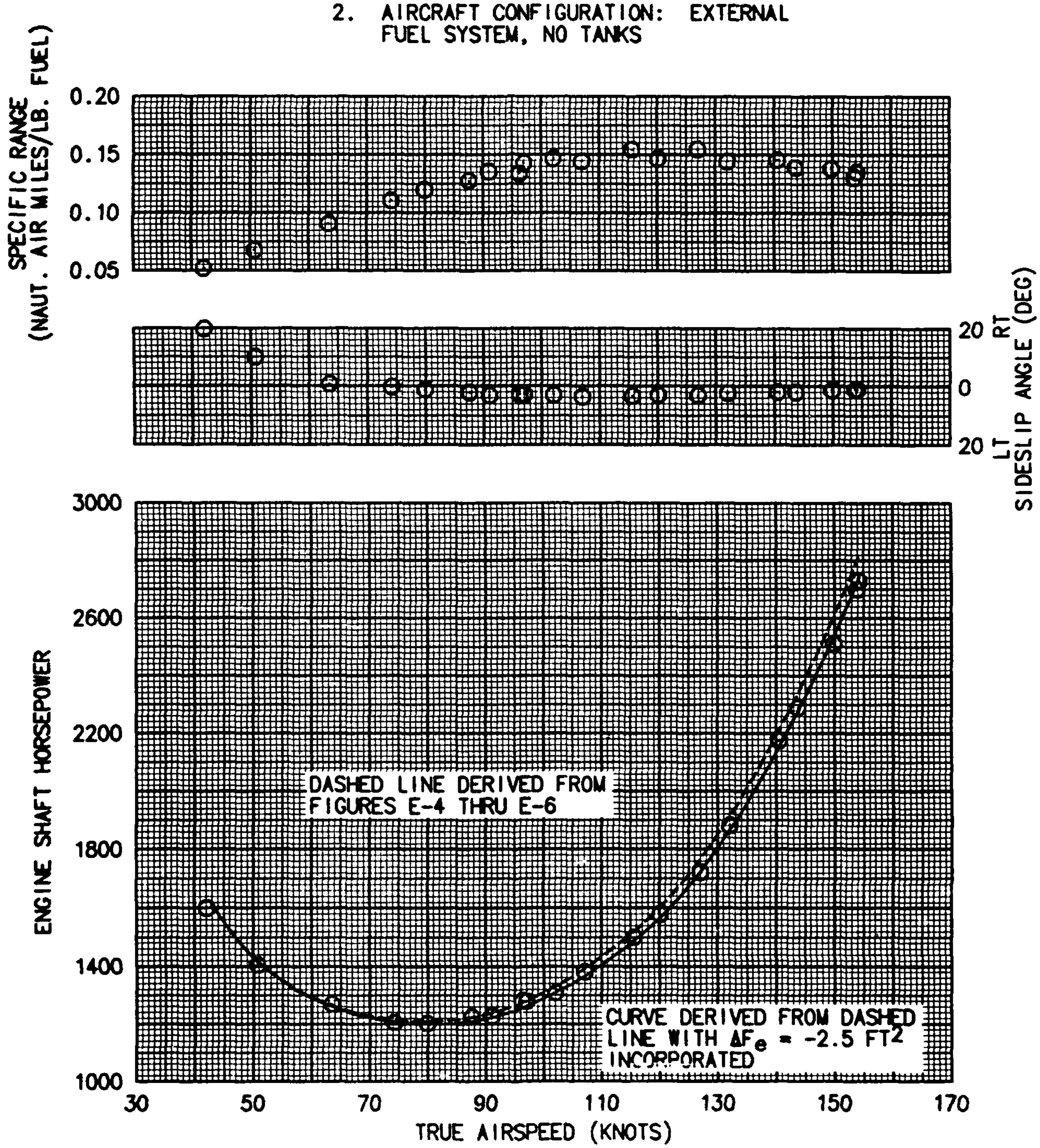


FIGURE E-12
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18800	347.1(FWD)	0.0	9190	9.5	258.4	.008927

NOTES: 1. BALL CENTERED TRIM CONDITION
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, NO TANKS

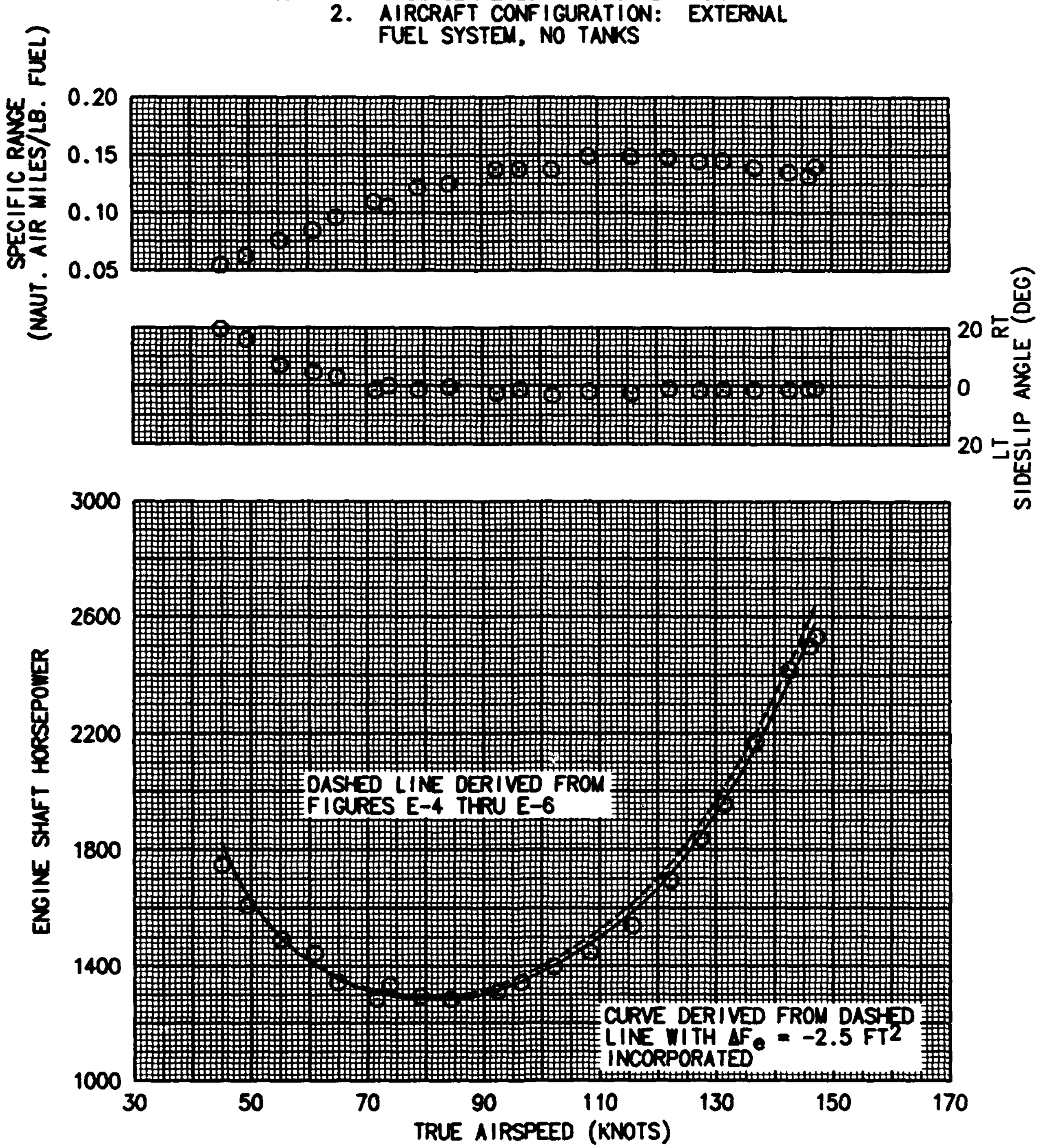


FIGURE E-13
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
17480	347.8(FWD)	0.0	4170	15.5	257.5	.007016

NOTES: 1. BALL CENTERED TRIM CONDITION
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS, CARGO DOORS AND GUNNER WINDOWS OPEN

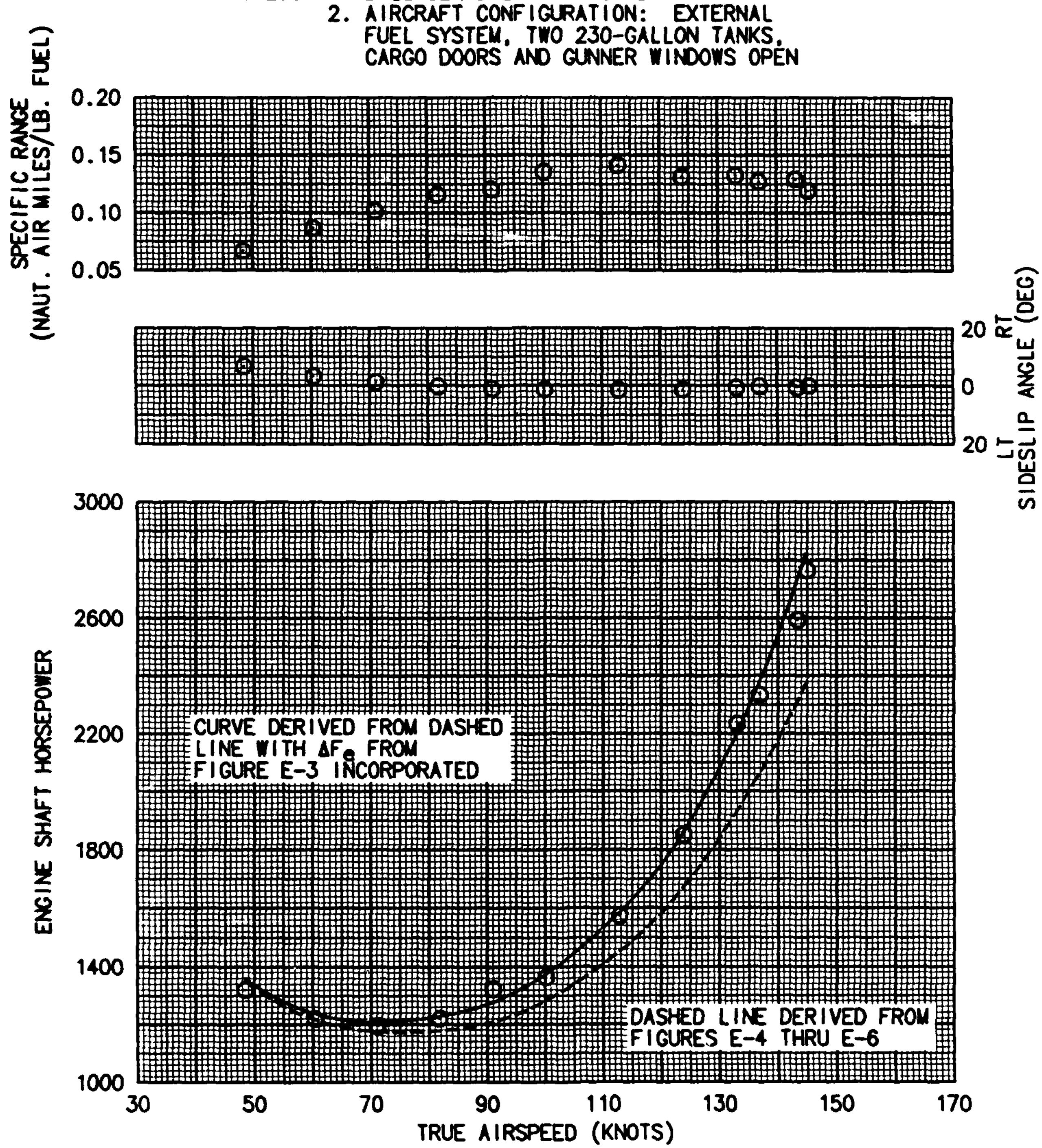


FIGURE E-14
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18970	347.2(FWD)	0.0	9510	14.0	258.1	.008976

NOTES: 1. BALL CENTERED TRIM CONDITION
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS, CARGO DOORS AND GUNNER WINDOWS OPEN

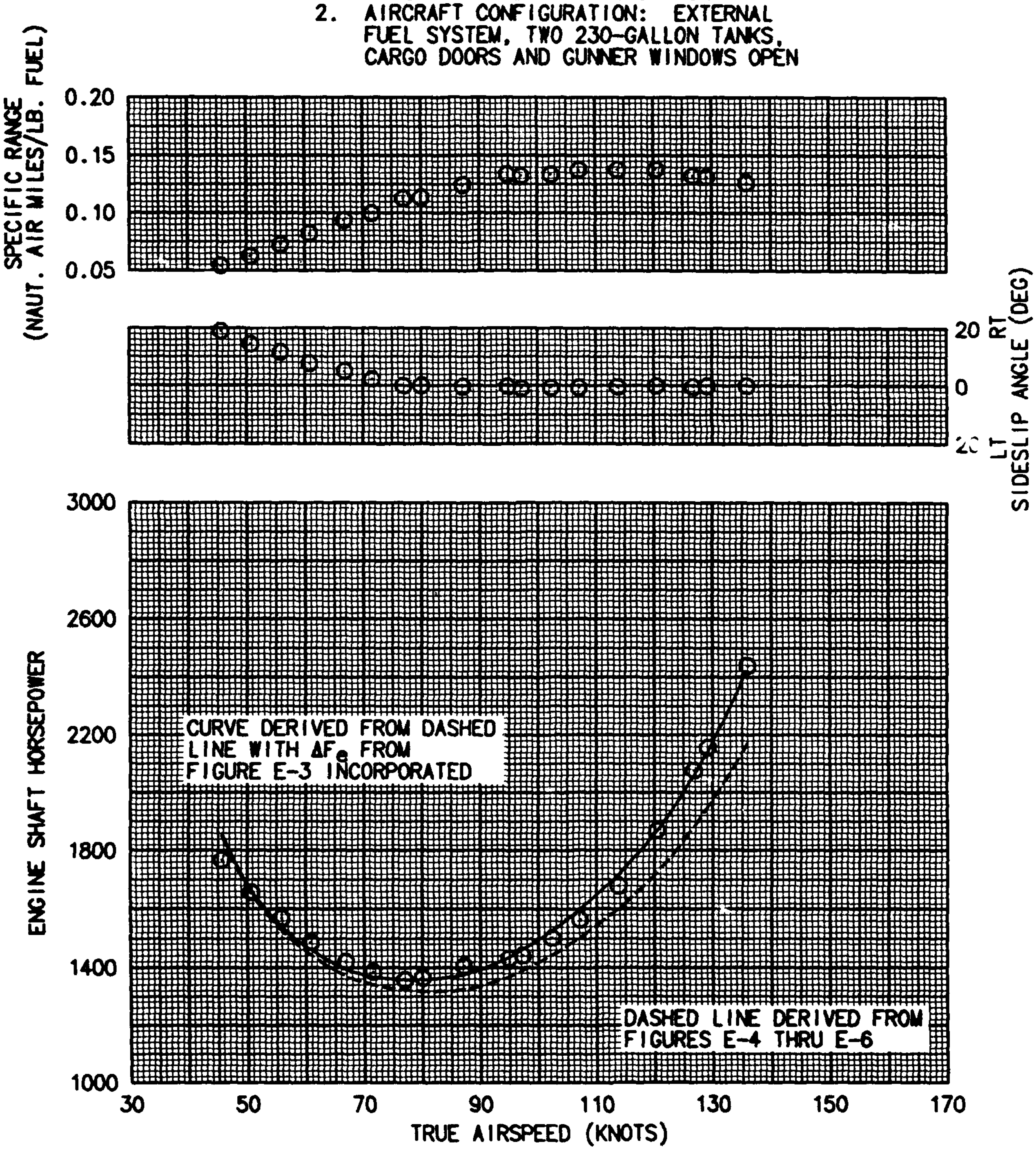


FIGURE E-15
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
17240	347.4(FWD)	0.0	3850	9.0	257.7	.007001

NOTES: 1. BALL CENTERED TRIM CONDITION
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS, CARGO DOORS AND GUNNER WINDOWS OPEN, PILOT/COPILOT DOORS REMOVED

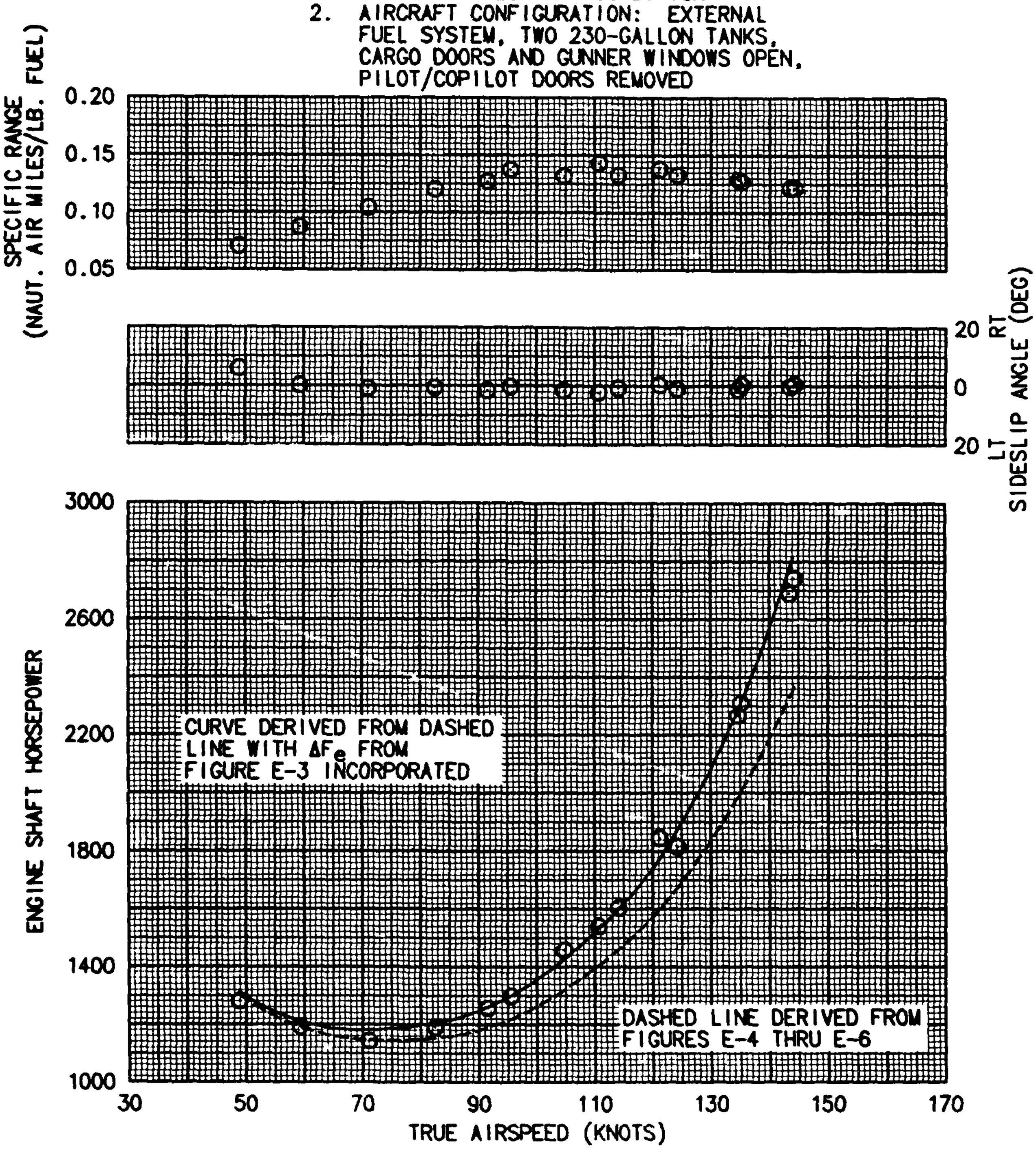


FIGURE E-16
LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
18810	347.1(FWD)	0.0	9710	14.0	258.2	.008950

NOTES: 1. BALL CENTERED TRIM CONDITION
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS, CARGO DOORS AND GUNNER WINDOWS OPEN, PILOT/COPILOT DOORS REMOVED

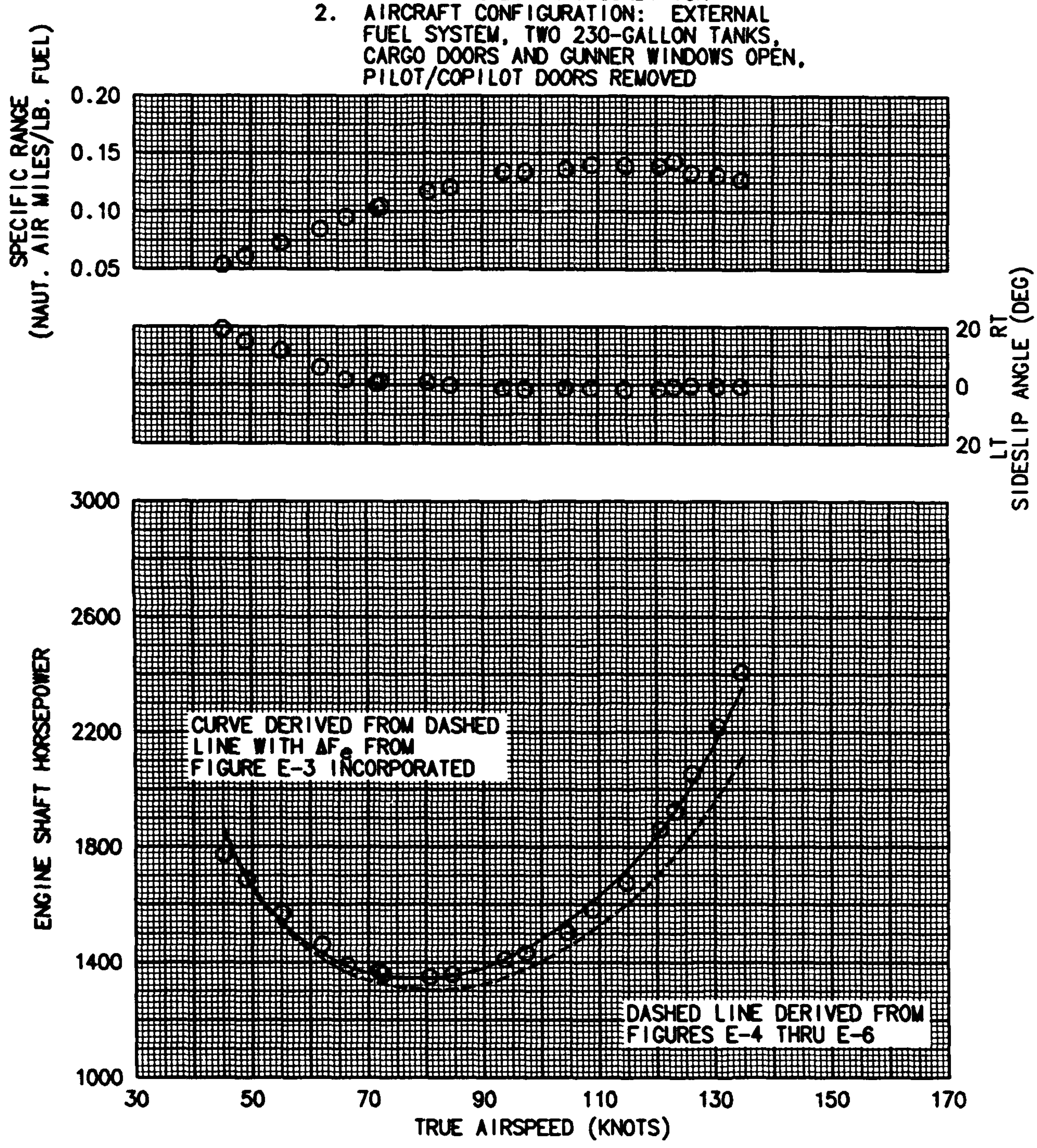


FIGURE E-17
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
○	17390	348.1(FWD)	0.0	4690	18.5	258.2	.006980
△	17540	348.0(FWD)	0.0	7920	11.0	258.3	.007970
◇	18630	347.2(FWD)	0.0	9010	4.0	257.8	.009013

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

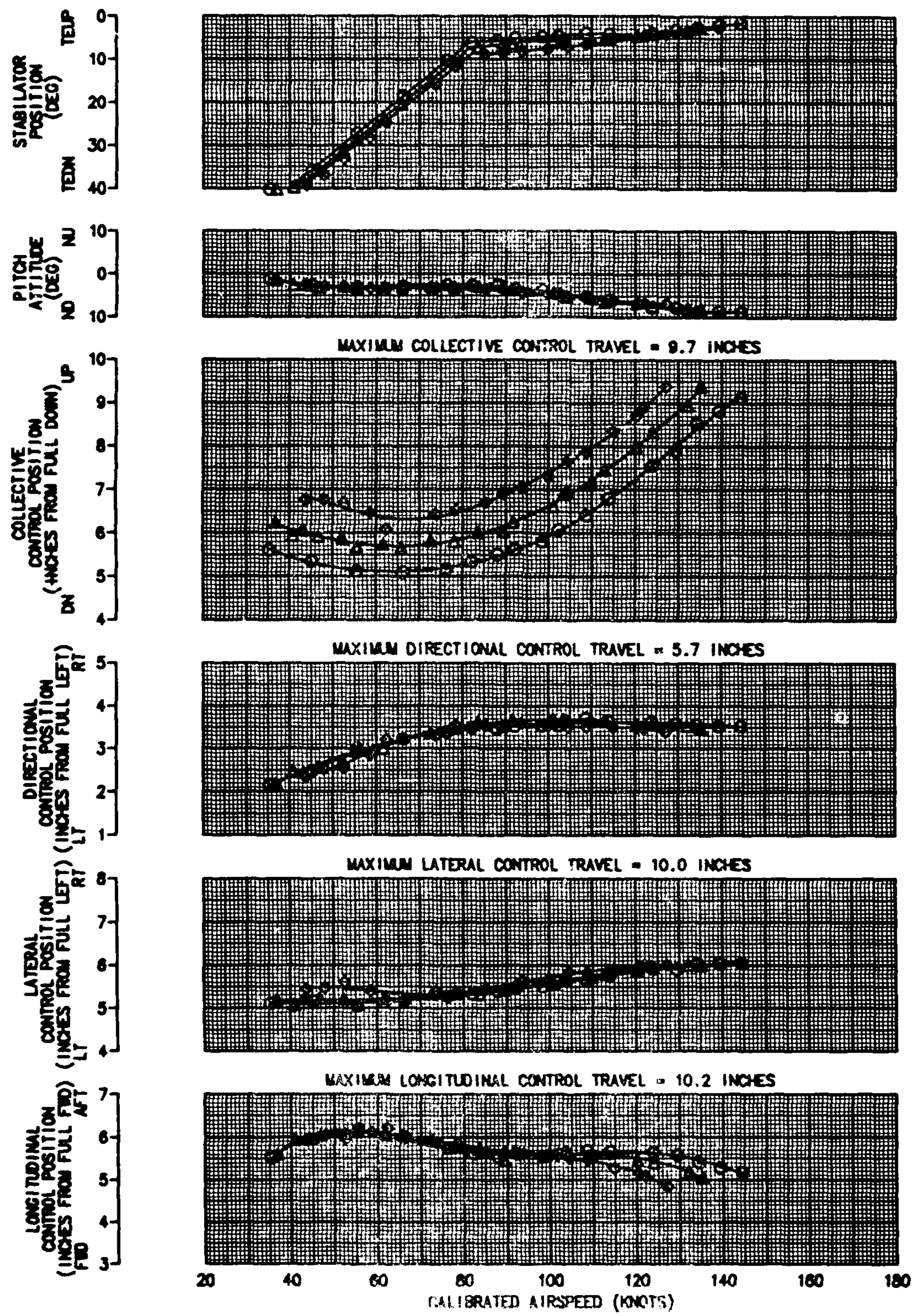


FIGURE E-18
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
○	17250	347.7(FWD)	0.0	5040	19.0	258.4	.006974
△	18170	347.6(FWD)	0.0	7040	13.0	258.3	.007979
◇	18800	347.1(FWD)	0.0	9190	9.5	258.4	.008927

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, NO TANKS

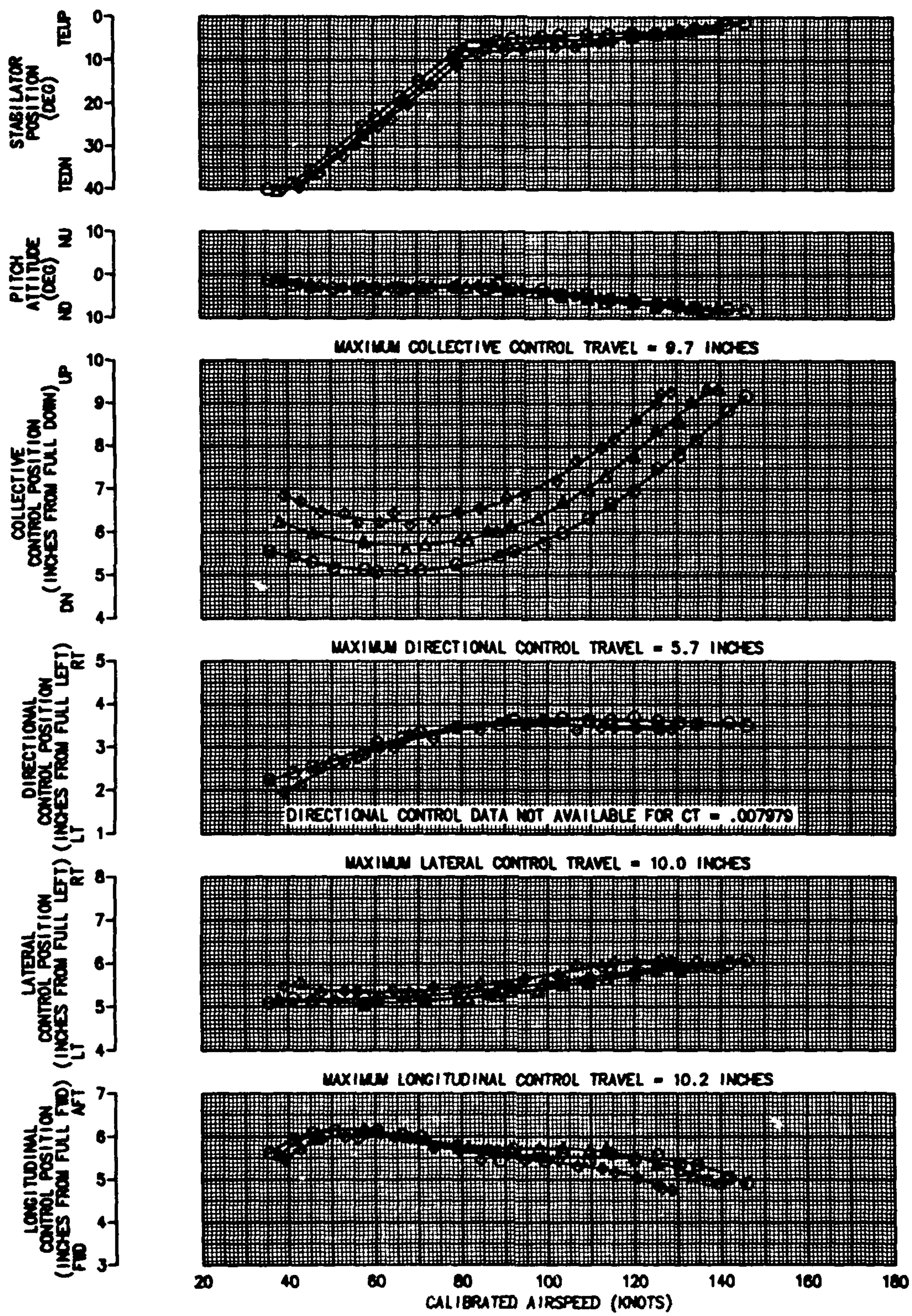


FIGURE E-19
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
⊙	17480	347.8(FWD)	0.0	4170	15.5	257.5	.007016
◇	18970	347.2(FWD)	0.0	9510	14.0	258.1	.008976

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS, CARGO DOORS AND GUNNER WINDOWS OPEN

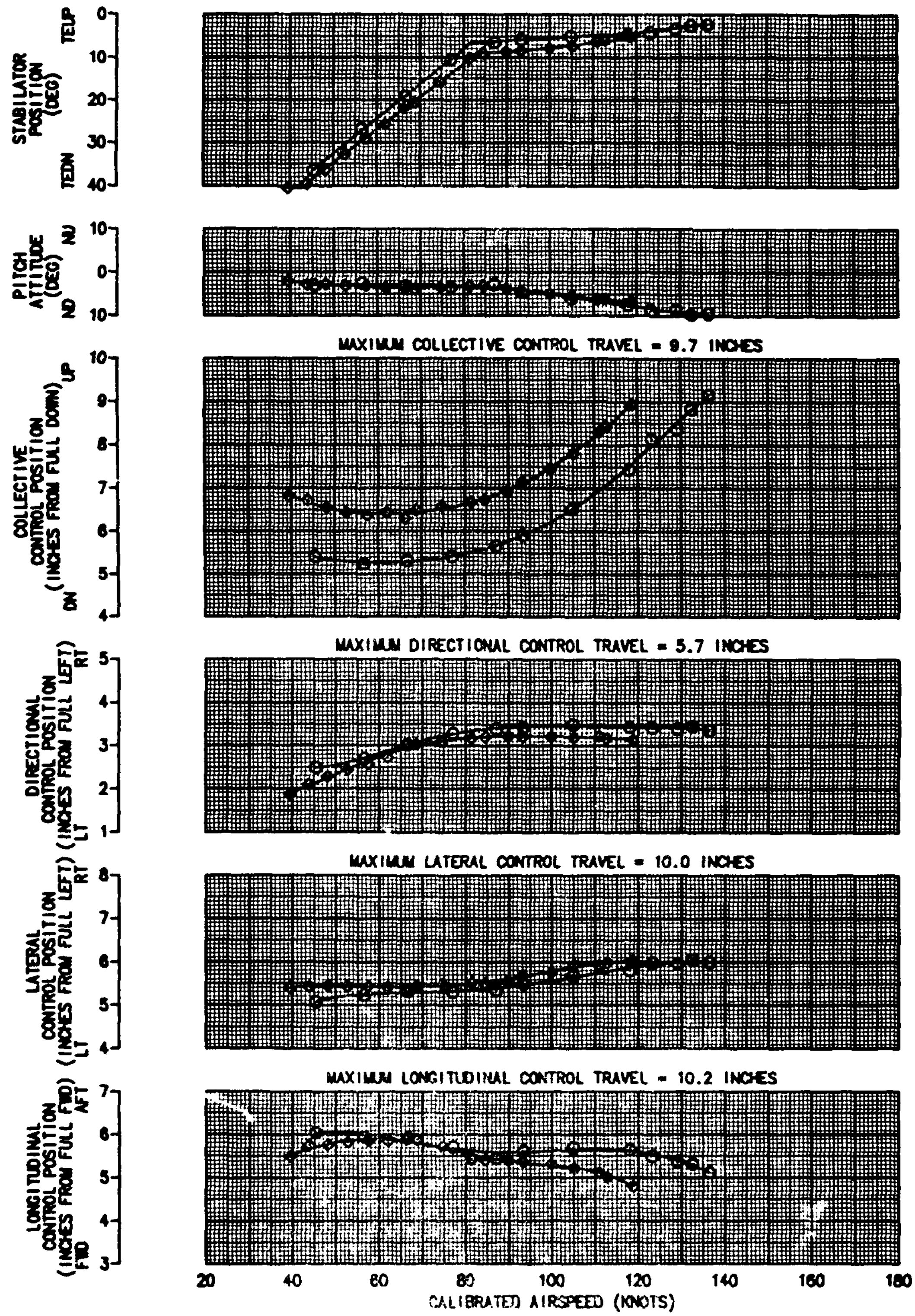


FIGURE E-20
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG COEFFICIENT OF THRUST
○	17240	347.4(FWD)	0.0	3850	9.0	257.7	.007001
◇	18810	347.1(FWD)	0.0	9710	14.0	258.2	.006950

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS, CARGO DOORS AND GUNNER WINDOWS OPEN, PILOT/COPILOT DOORS REMOVED

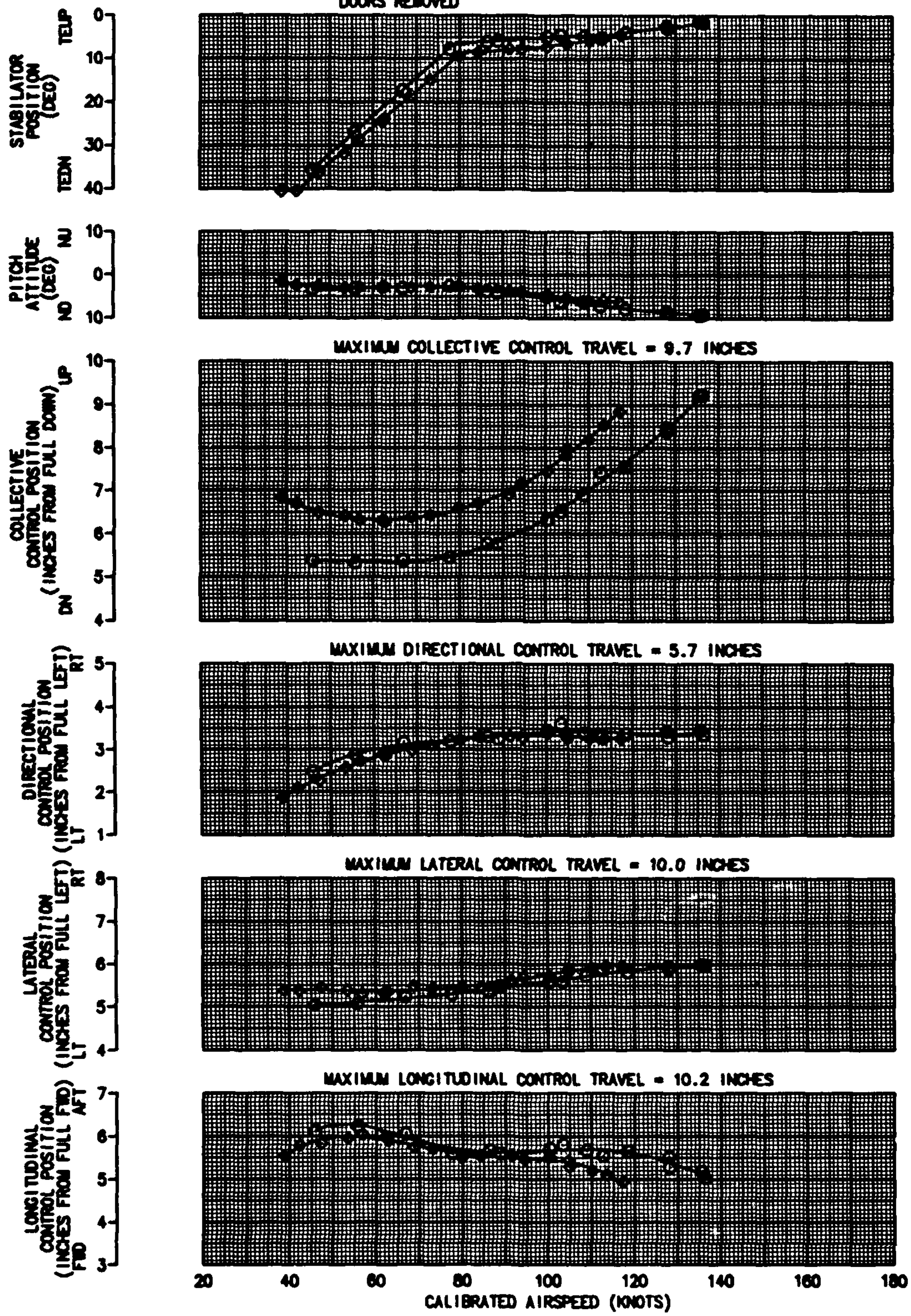


FIGURE E-21

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY IN LEVEL FLIGHT

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
○	19600	361.0(AFT)	0.0	5500	0.0	257
◇	18980	360.9(AFT)	0.0	6490	-1.0	258

NOTES:
1. SOLID SYMBOLS DENOTE TRIM
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

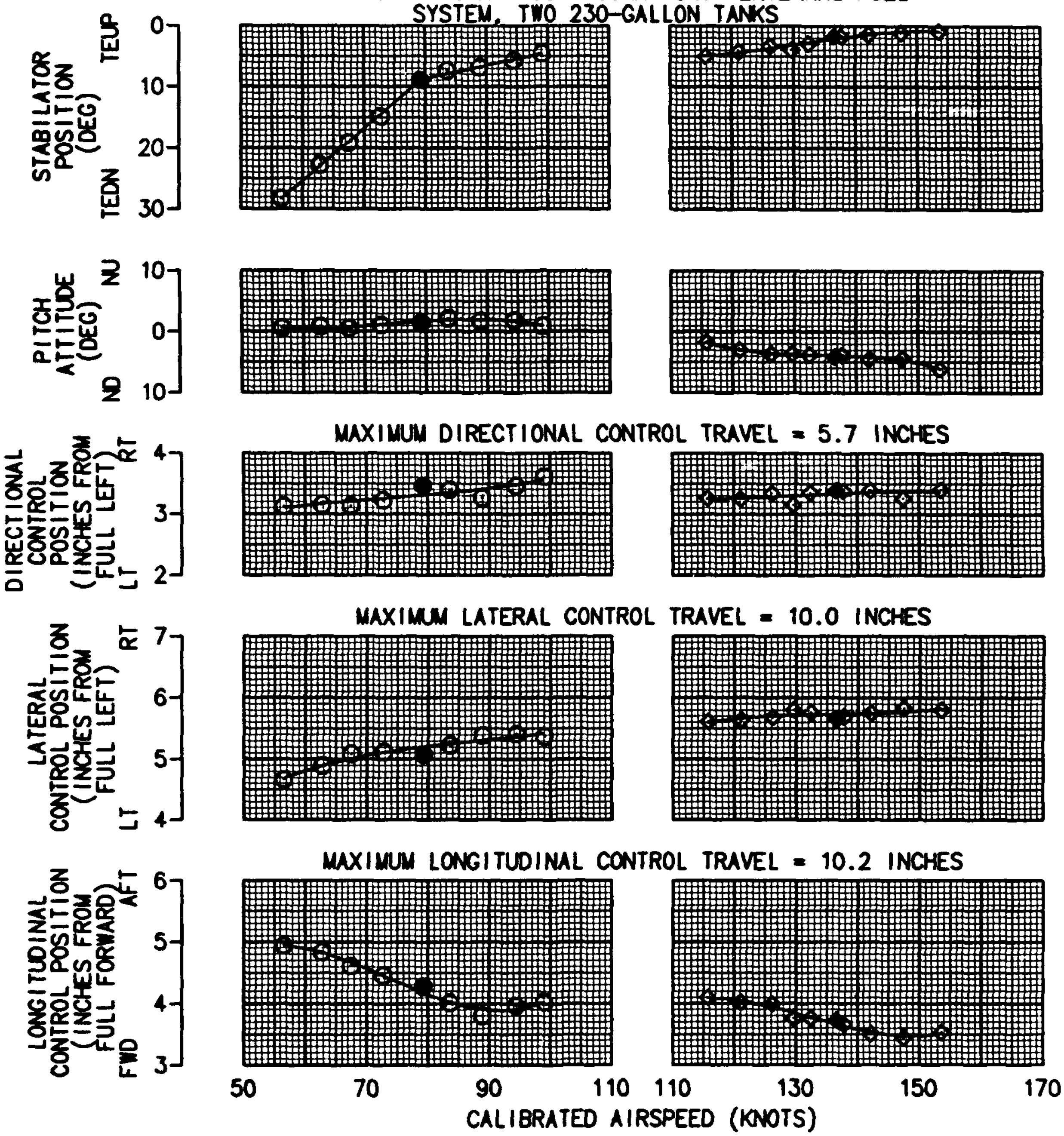


FIGURE E-22

COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY IN CLIMBING FLIGHT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
18560	361.0(AFT)	0.0	6740	0.0	257

NOTES:
1. SOLID SYMBOLS DENOTE TRIM
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AVERAGE ENGINE TORQUE = 94 PERCENT
4. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

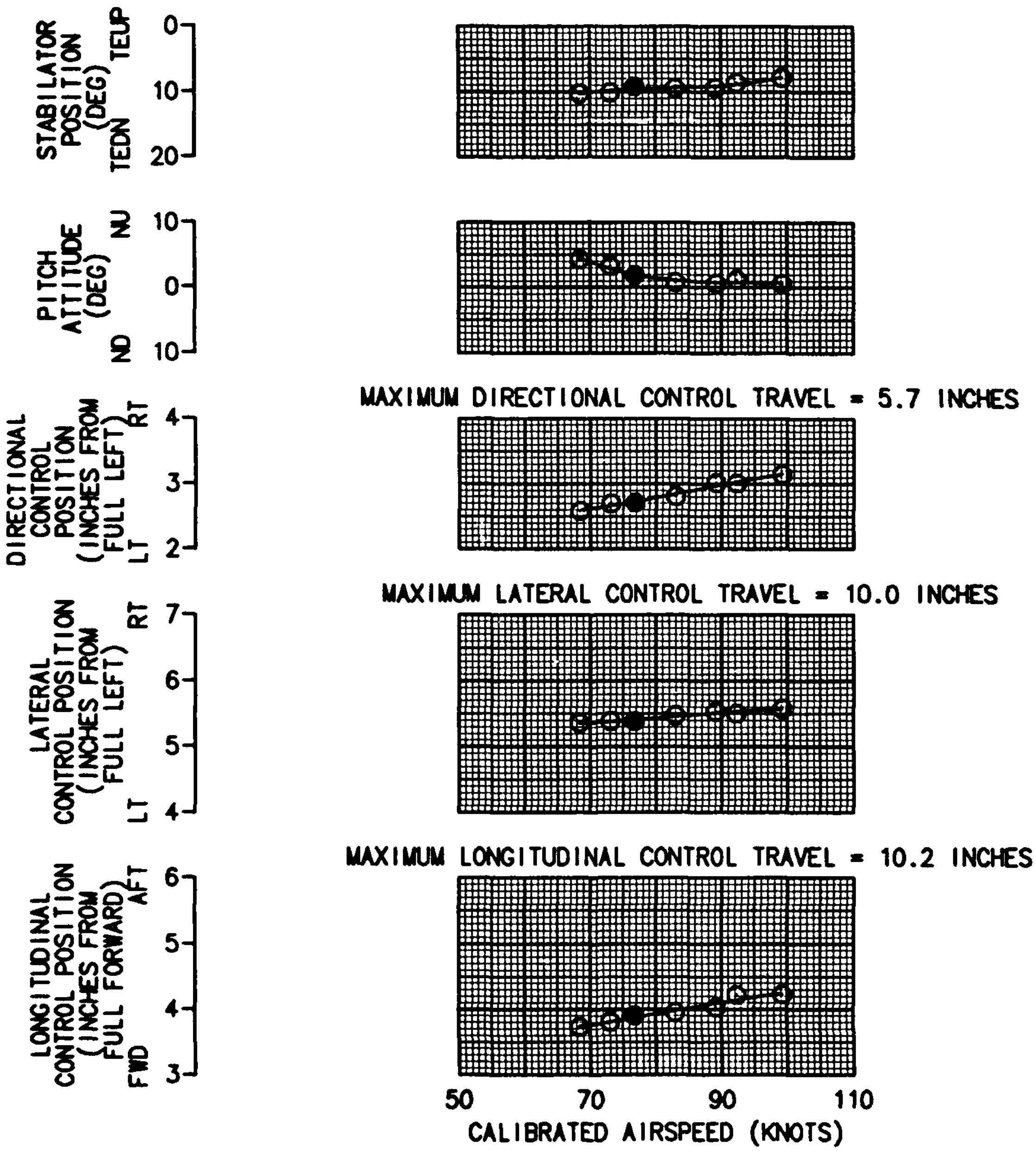


FIGURE E-23
COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY IN AUTOROTATIONAL FLIGHT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
18950	361.1(AFT)	0.0	6260	16.5	258

NOTES: 1. SOLID SYMBOLS DENOTE TRIM
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

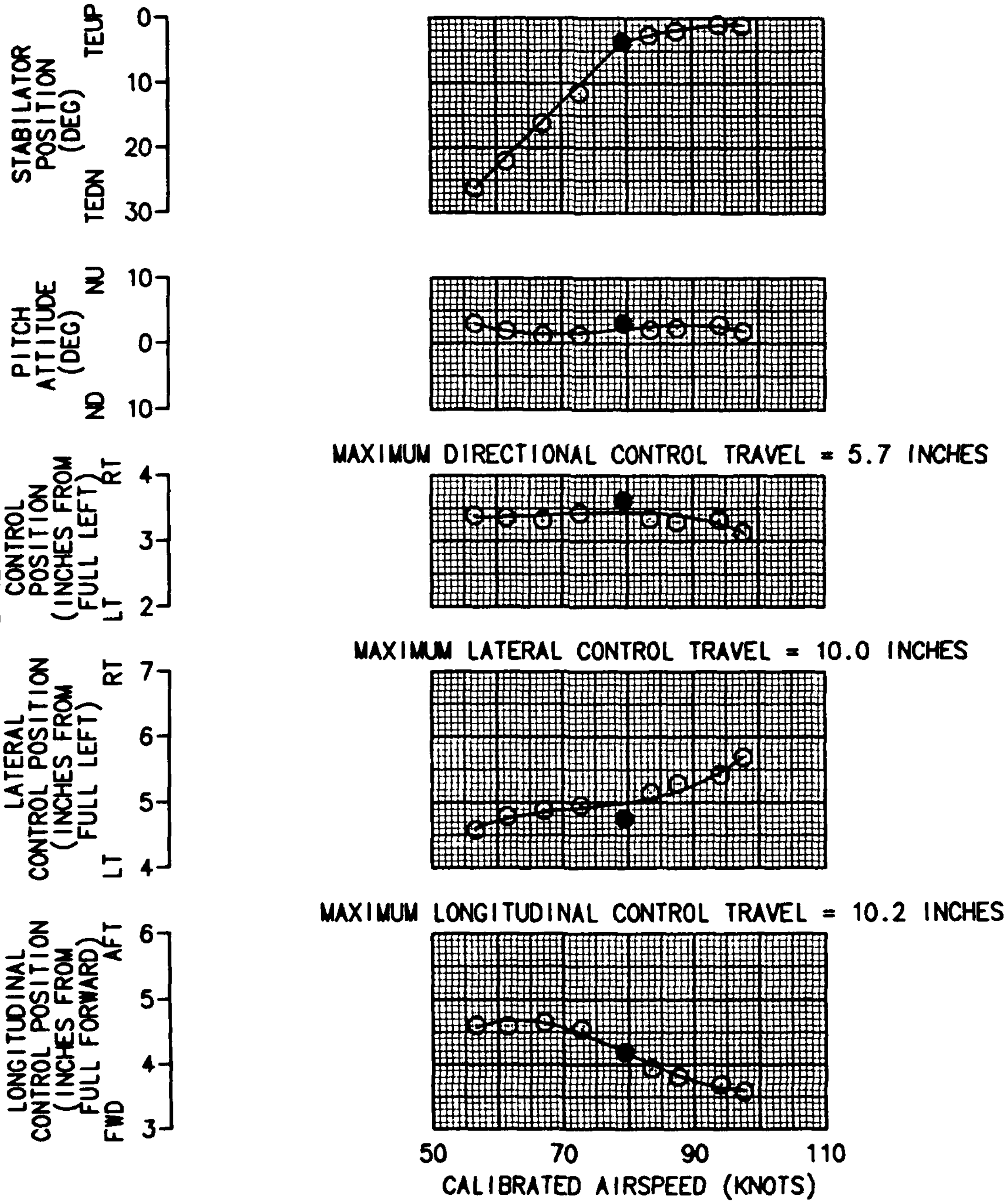


FIGURE E-24

COLLECTIVE-FIXED STATIC LATERAL-DIRECTIONAL STABILITY IN LEVEL FLIGHT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
19510	361.1(AFT)	0.0	5520	12.5	258	78

NOTES: 1. SOLID SYMBOLS DENOTE TRIM
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

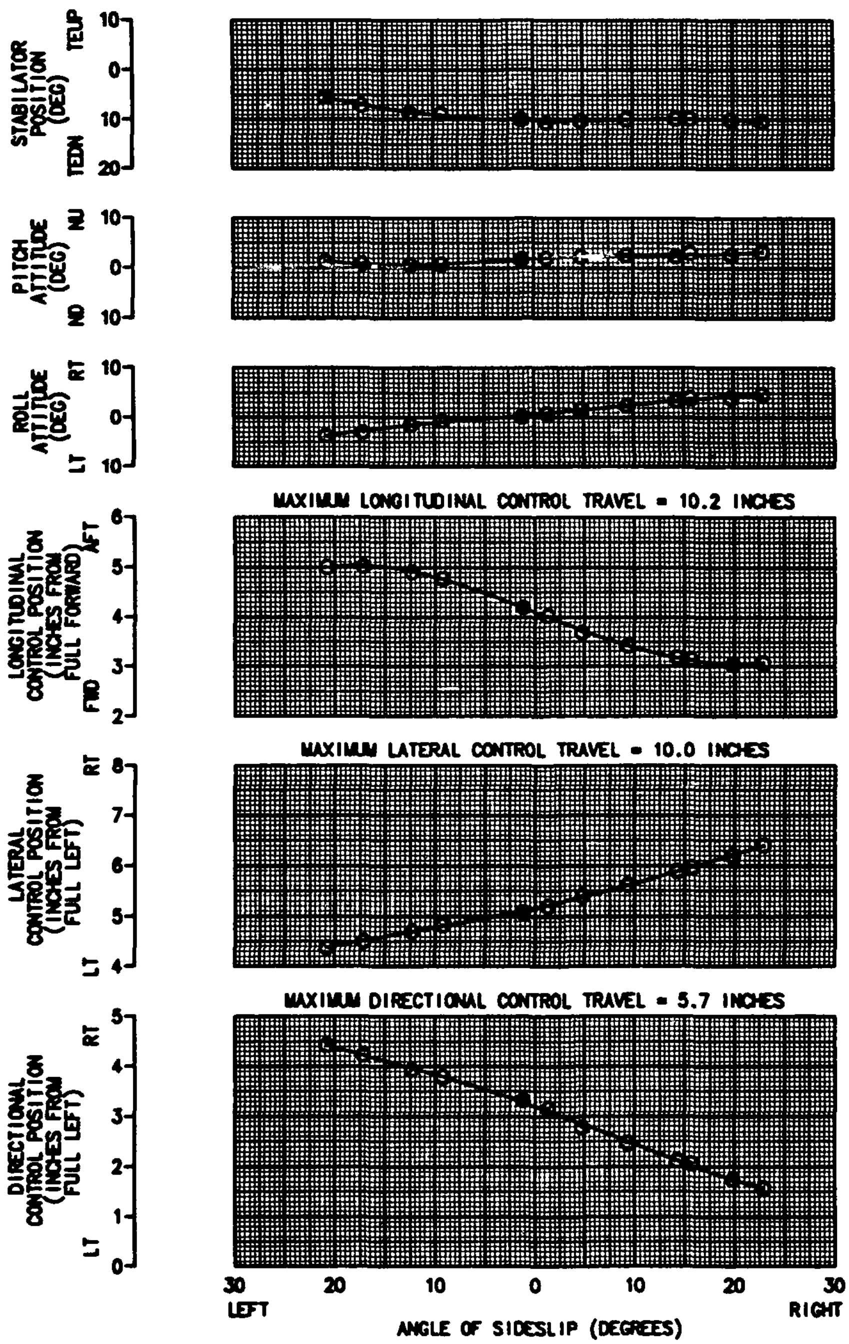


FIGURE E-25

COLLECTIVE-FIXED STATIC LATERAL-DIRECTIONAL STABILITY IN LEVEL FLIGHT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
18990	361.0(AFT)	0.0	6420	12.0	258	135

NOTES: 1. SOLID SYMBOLS DENOTE TRIM
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

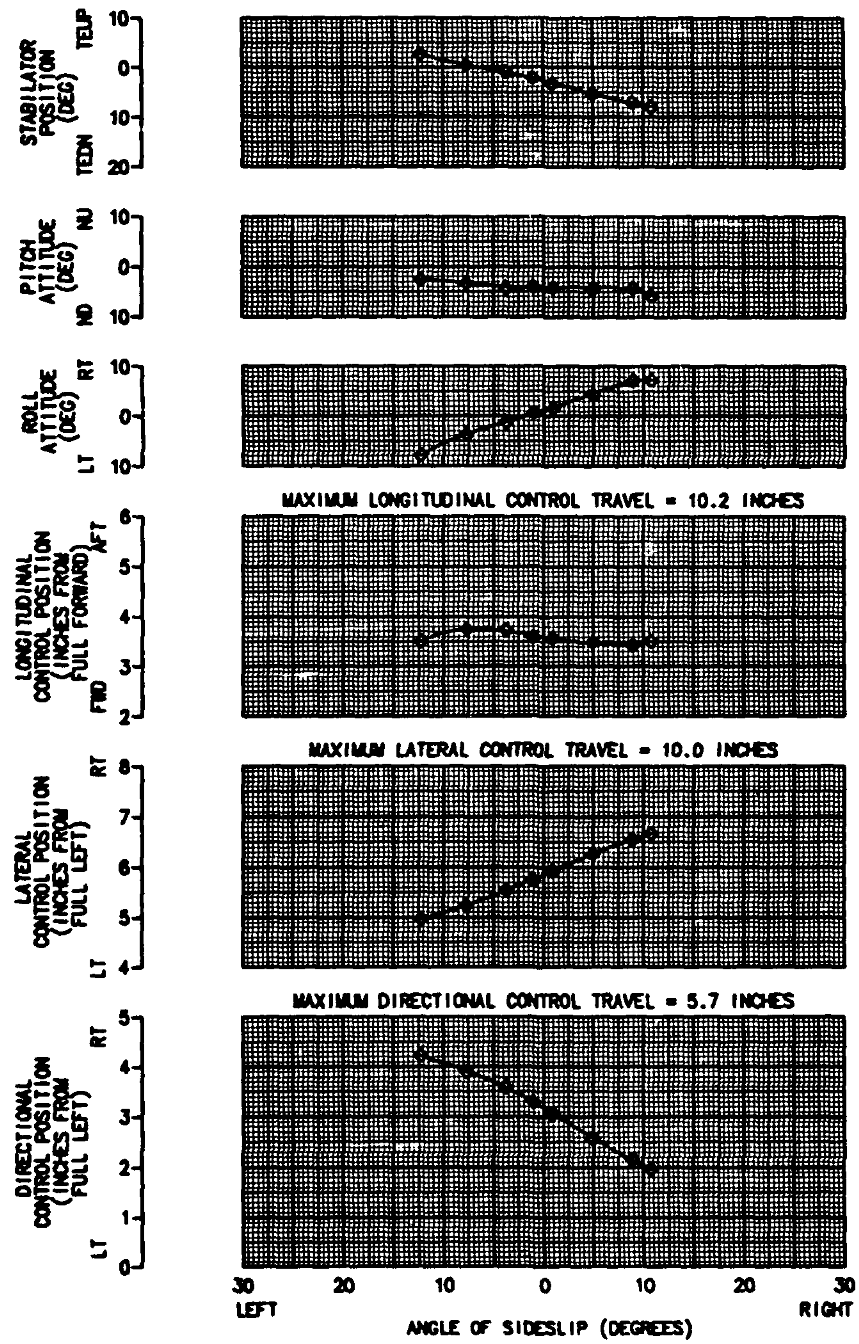


FIGURE E-26
COLLECTIVE-FIXED STATIC LATERAL-DIRECTIONAL STABILITY IN CLIMBING FLIGHT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
[illegible]	360.8(AFT)	0.0	6330	17.5	258	78

NOTES: 1. SOLID SYMBOLS DENOTE TRIM
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AVERAGE ENGINE TORQUE = 89 PERCENT
4. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

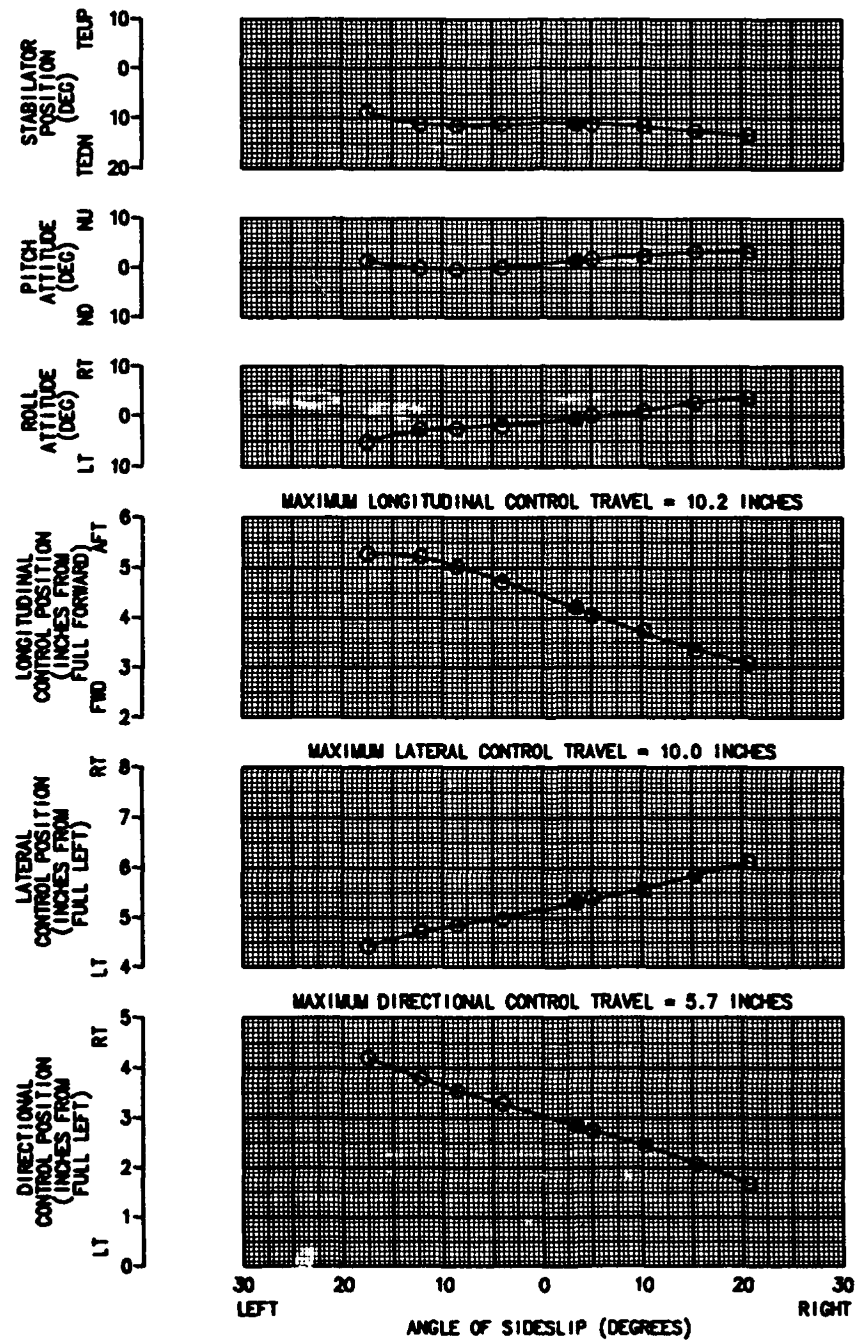


FIGURE E-27

COLLECTIVE-FIXED STATIC LATERAL-DIRECTIONAL STABILITY IN AUTOROTATIONAL FLIGHT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
19250	361.2(AFT)	0.0	5980	18.0	258	78

NOTES: 1. SOLID SYMBOLS DENOTE TRIM
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

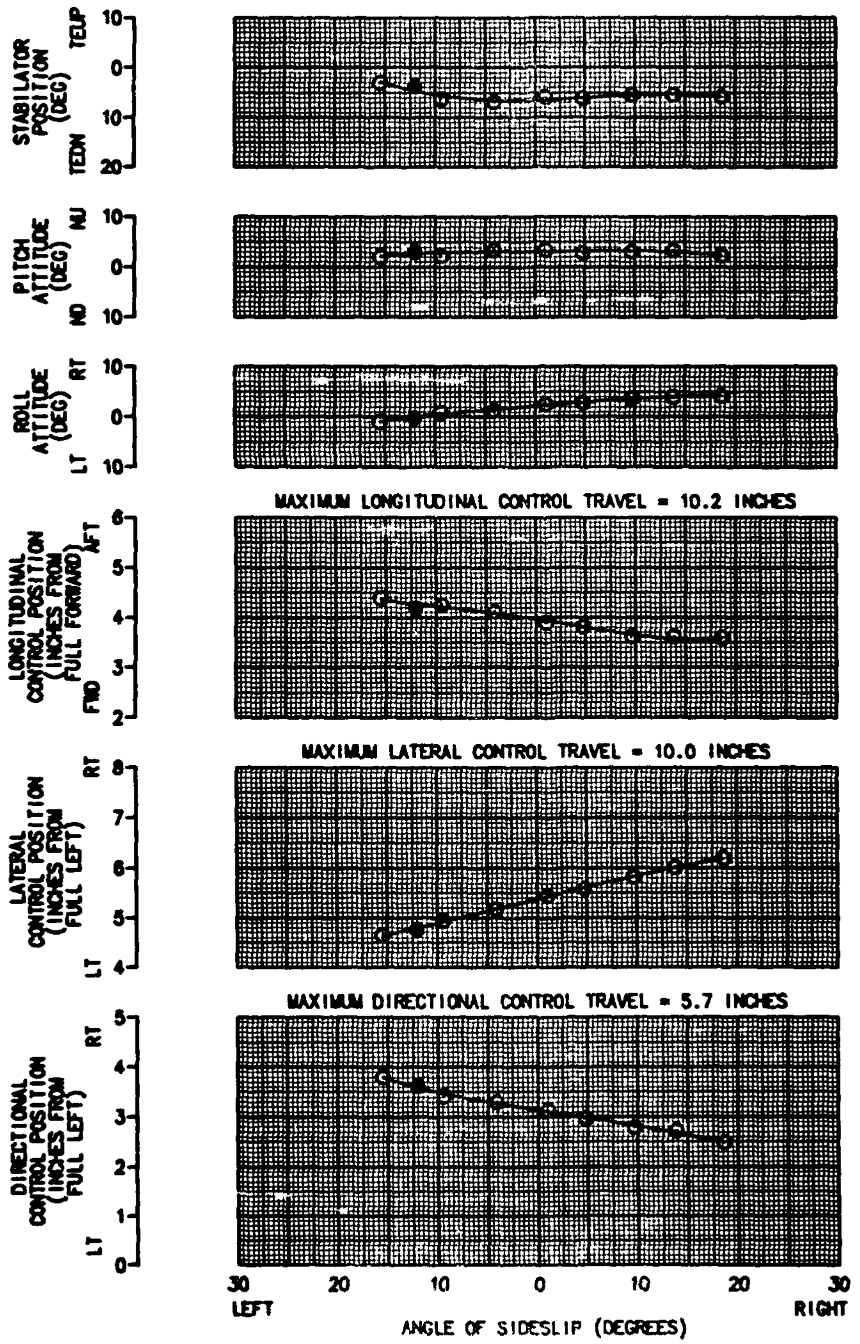


FIGURE E-28
MANEUVERING STABILITY
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)
□	19540	361.0(AFT)	0.0	6060	16.0	258	79
⊙	18880	360.9(AFT)	0.0	6380	16.0	257	134

NOTES:
1. SOLID SYMBOLS DENOTE TRIM, OPEN SYMBOLS DENOTE LEFT TURN, CROSSED SYMBOLS DENOTE RIGHT TURN
2. PBA CENTERED AND ELECTRICALLY DISCONNECTED
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

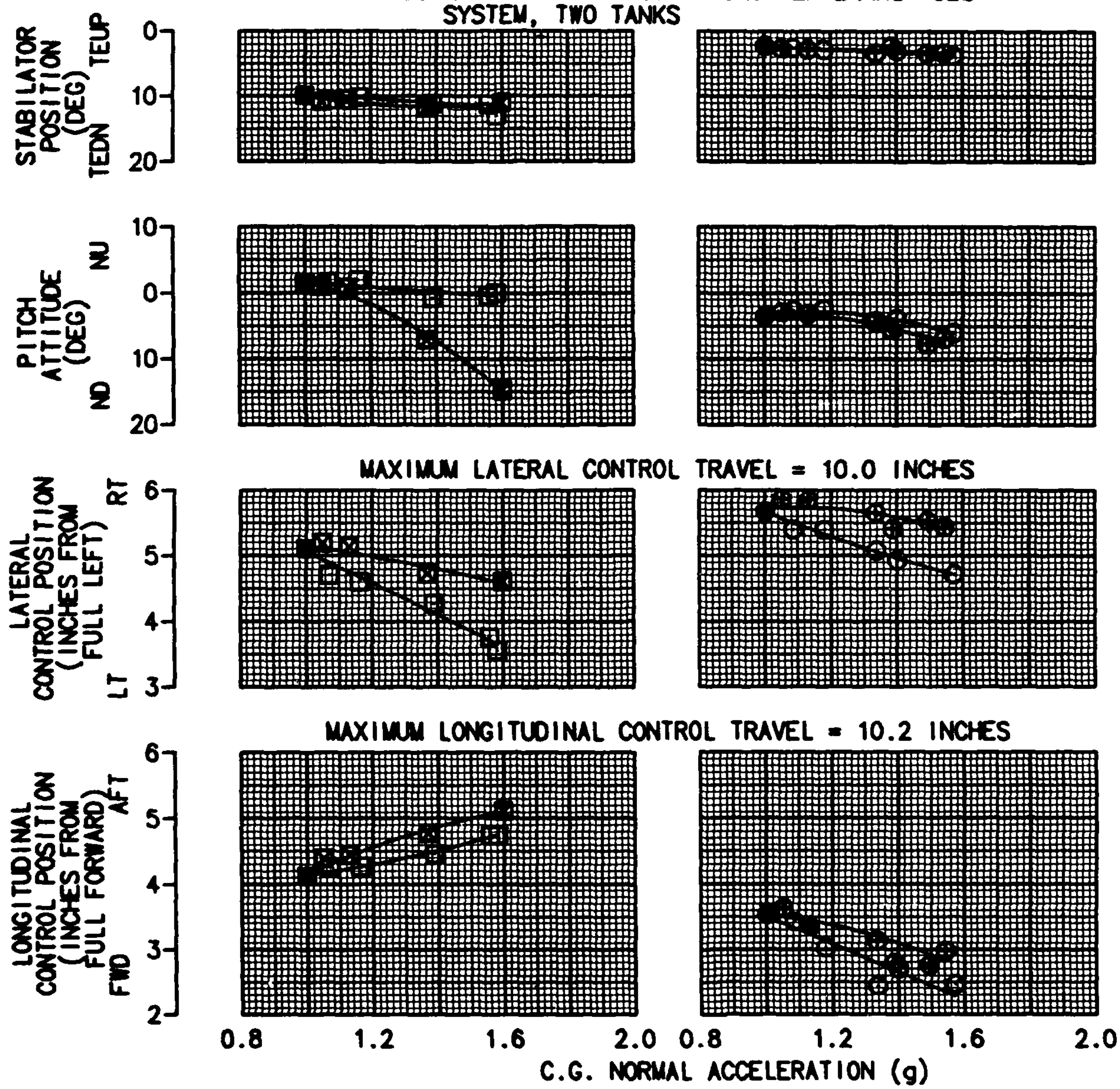


FIGURE E-29

AFT LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19530	360.8(AFT)	0.0	6330	22.0	258	79	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

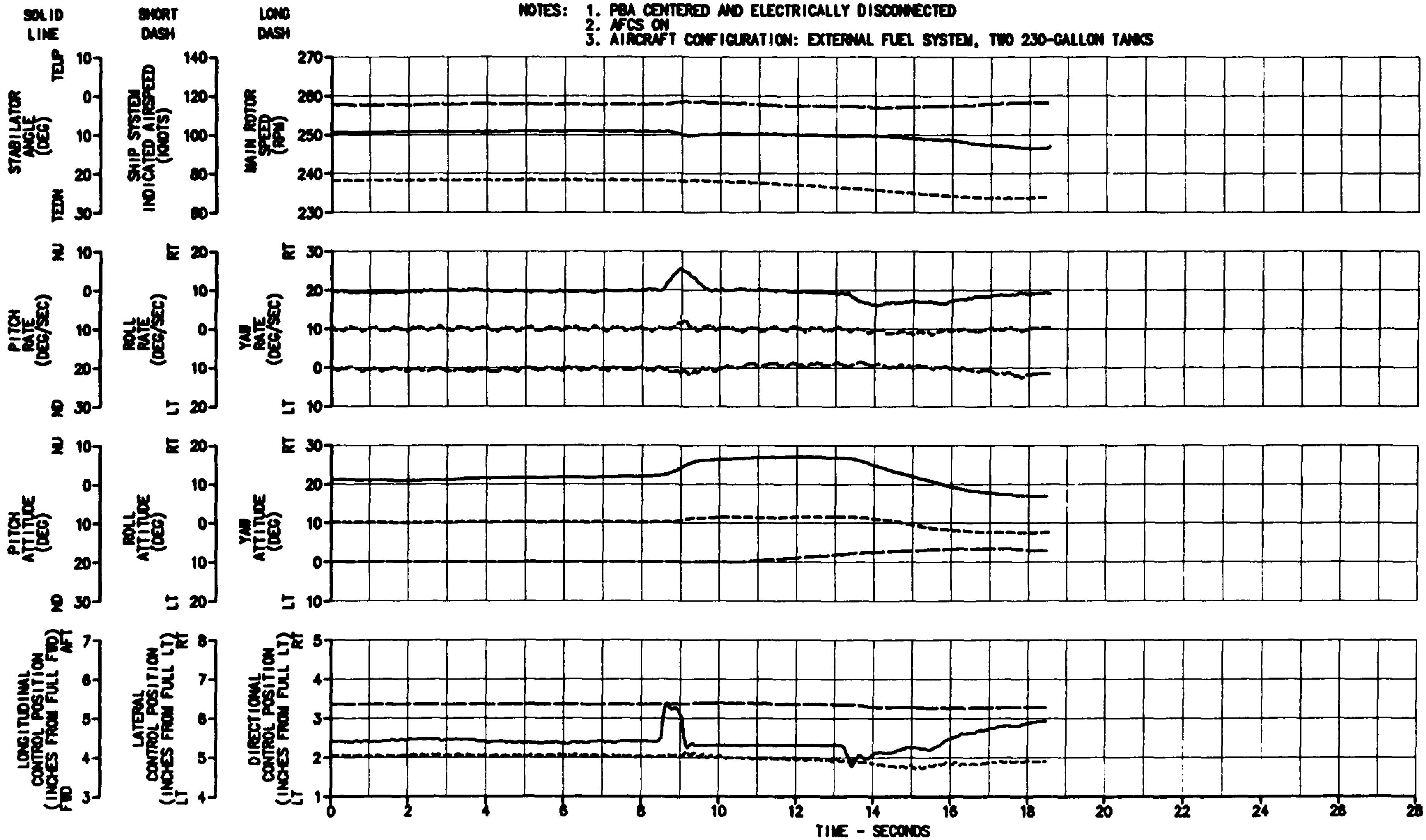


FIGURE E-30
FORWARD LONGITUDINAL PULSE INPUT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19060	360.7(AFT)	0.0	6570	24.0	258	137	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

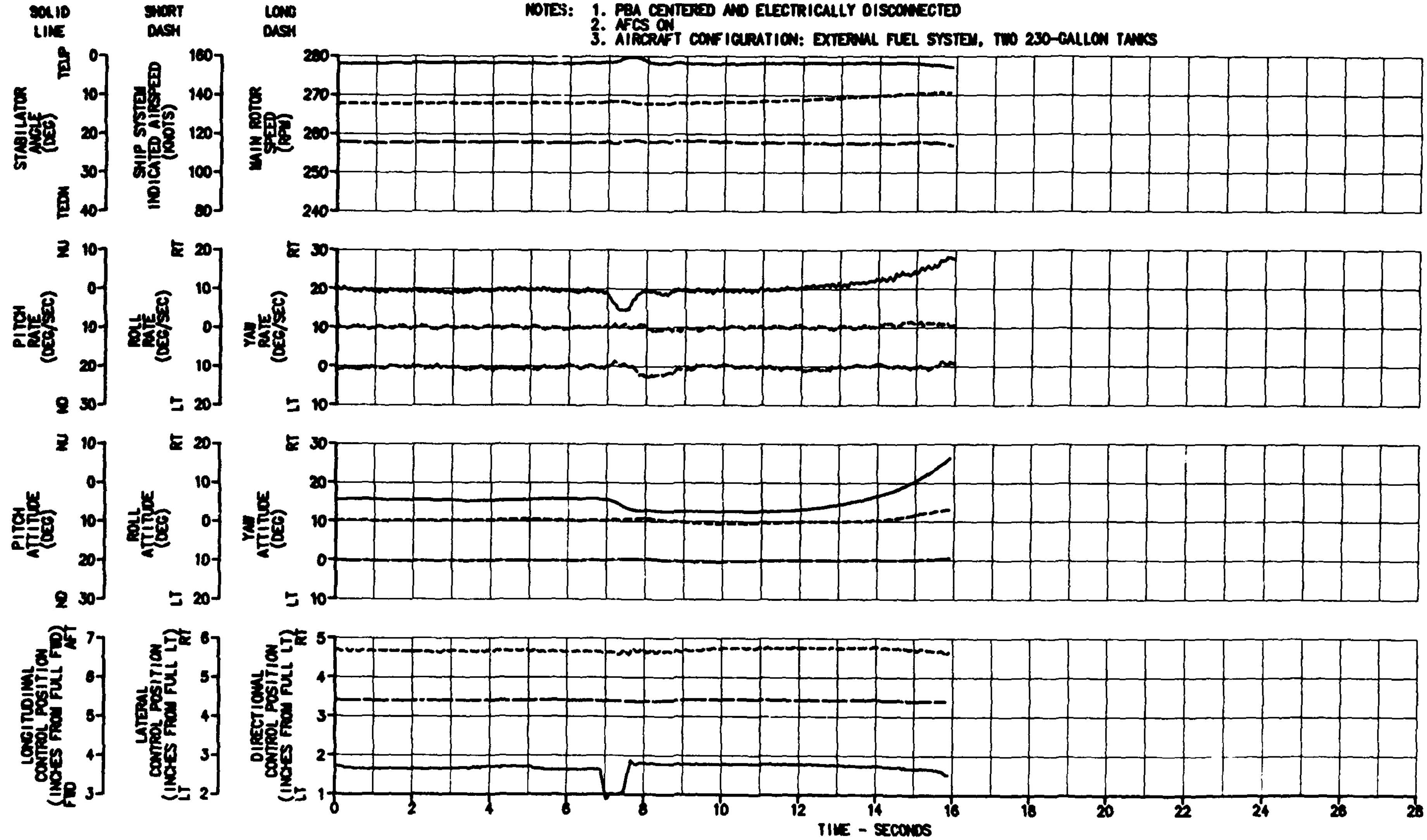


FIGURE E-31

FORWARD LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19870	360.5(AFT)	0.0	5960	24.0	258	76	IRP CLIMB

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

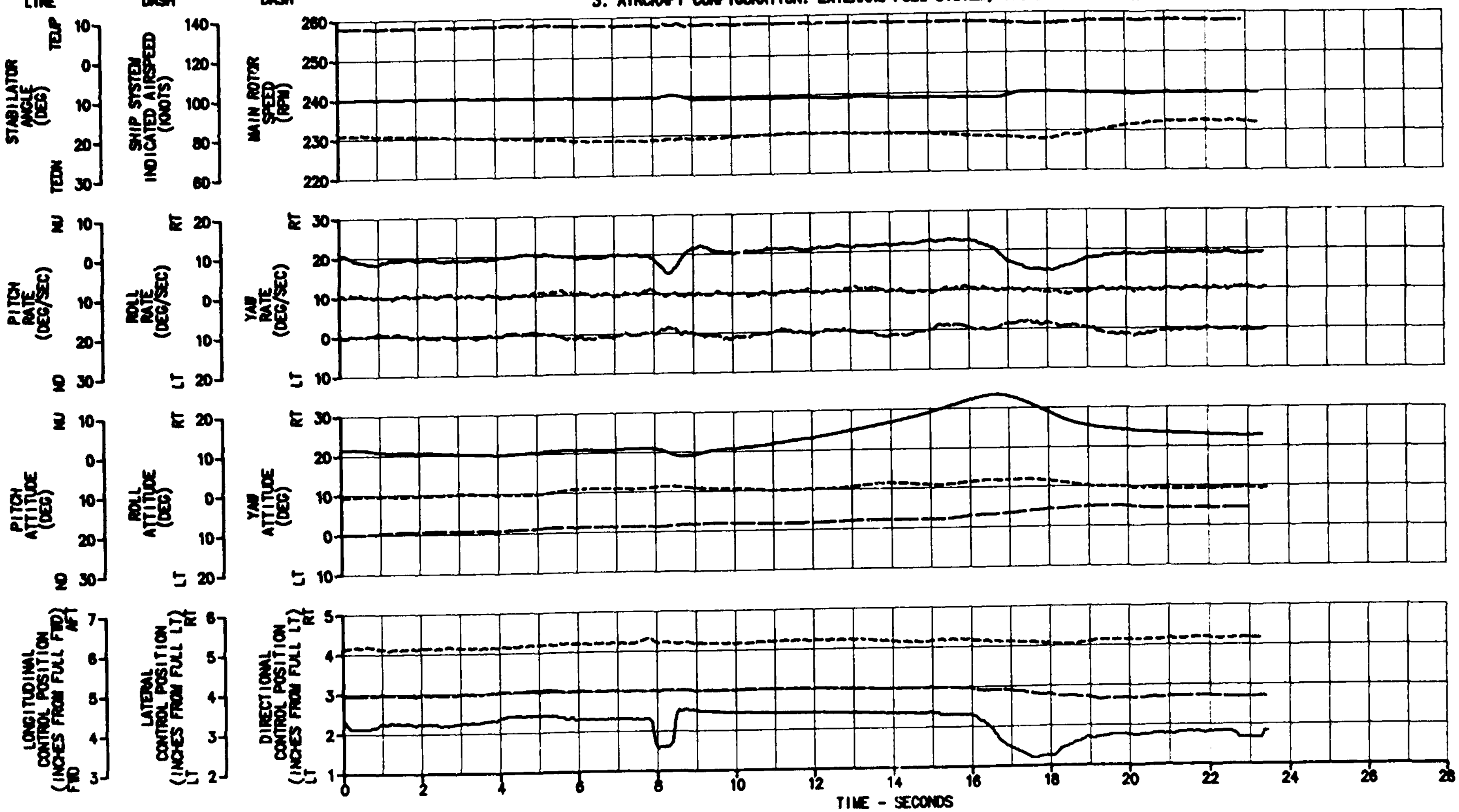


FIGURE E-32

AFT LONGITUDINAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19560	360.2(AFT)	0.0	6980	20.5	259	80	AUTOROTATION

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

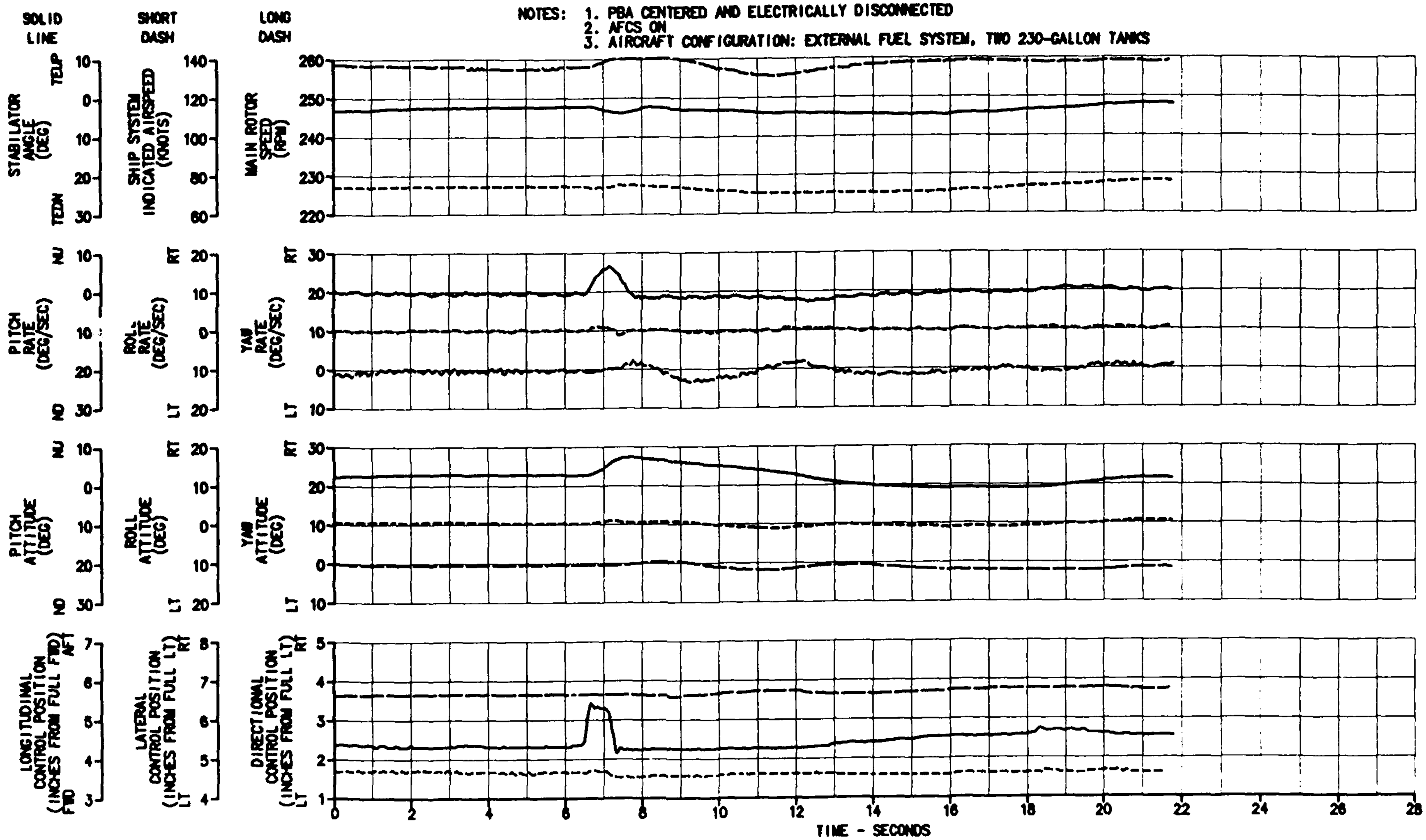


FIGURE E-33
RIGHT LATERAL PULSE INPUT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19430	361.0(AFT)	0.0	6410	22.0	258	79	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

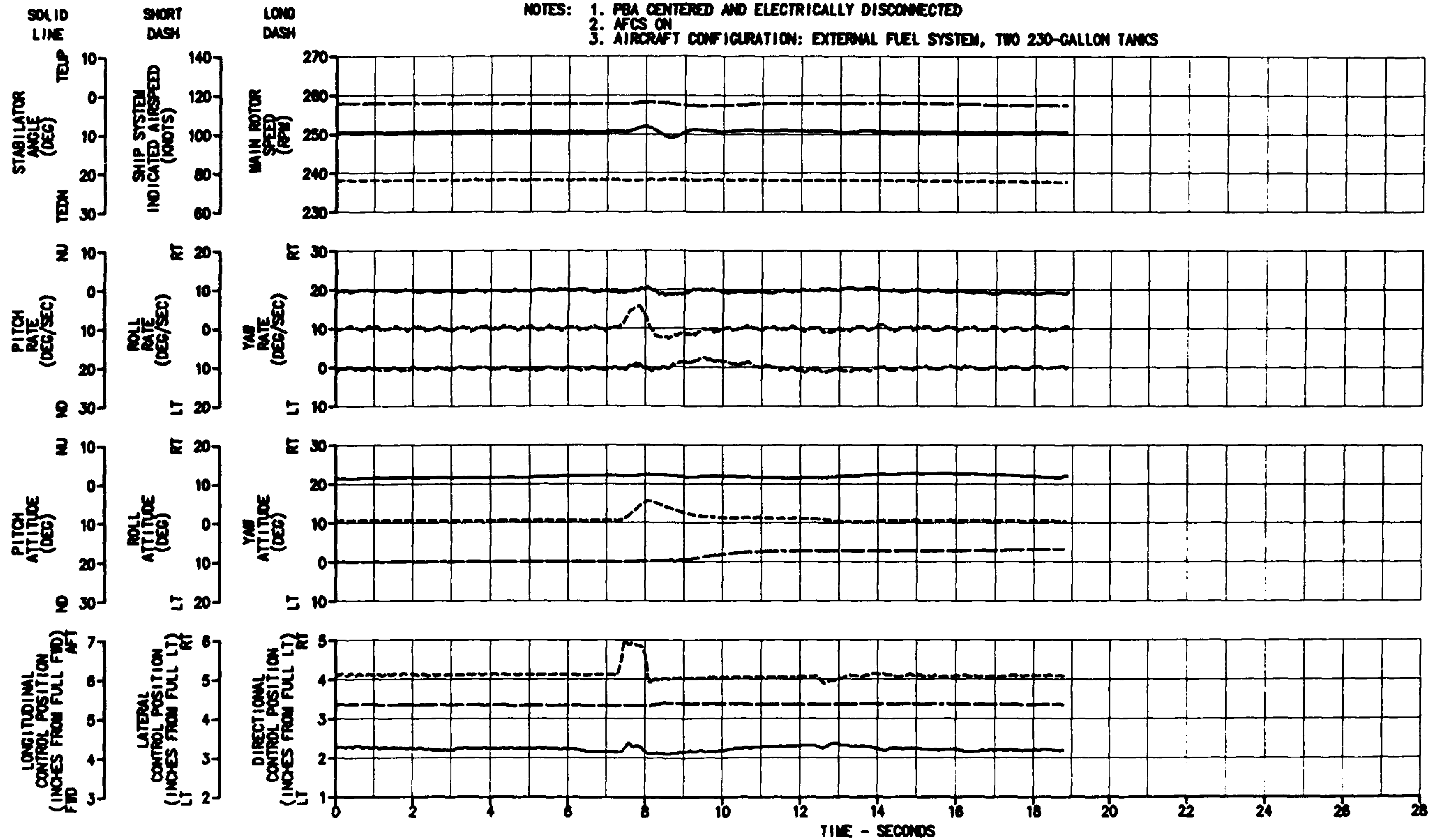


FIGURE E-34
LEFT LATERAL PULSE INPUT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
18930	360.8(AFT)	0.0	6490	24.0	258	132	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

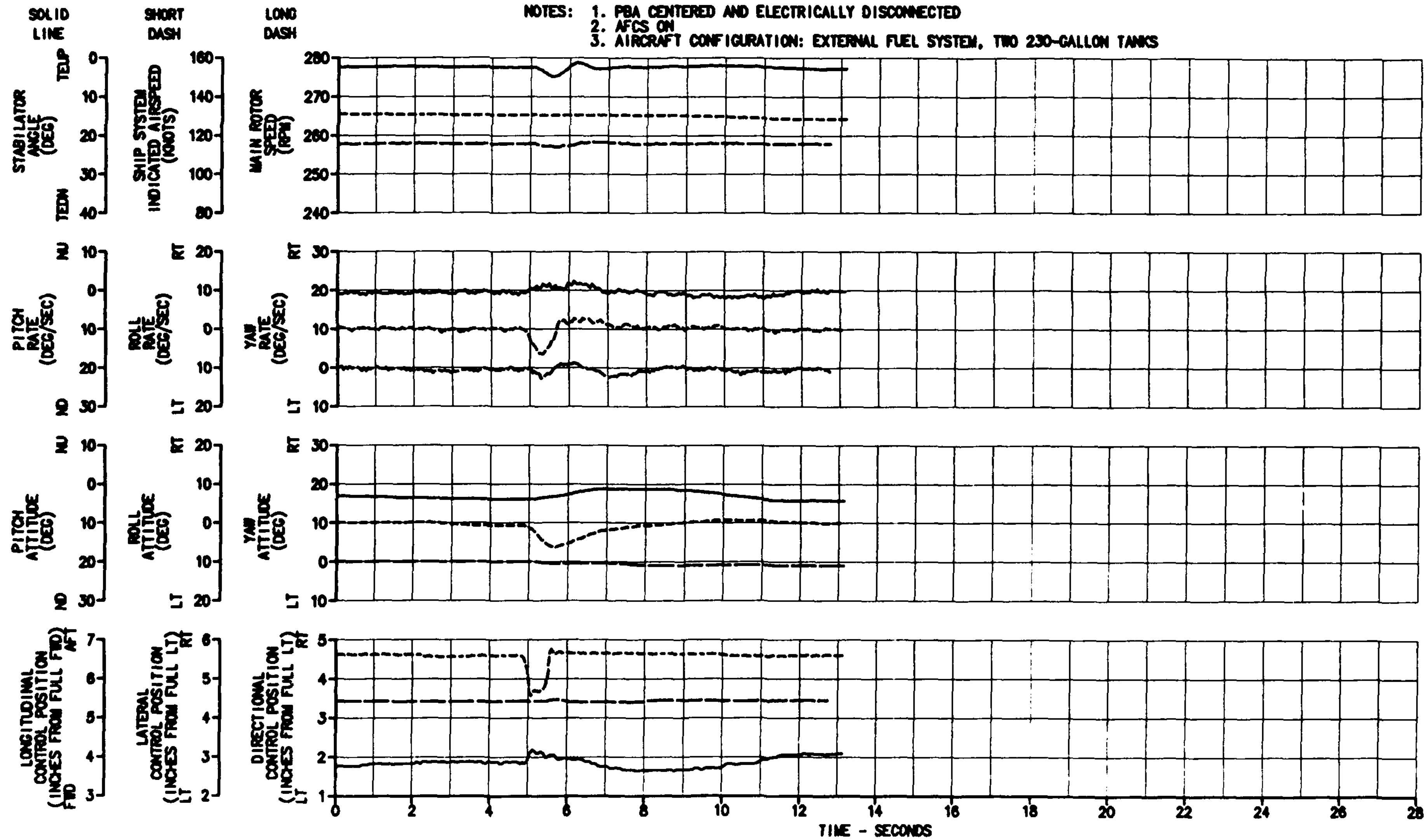


FIGURE E-35

LEFT LATERAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19500	360.2(AFT)	0.0	6240	23.0	258	77	IRP CLIMB

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

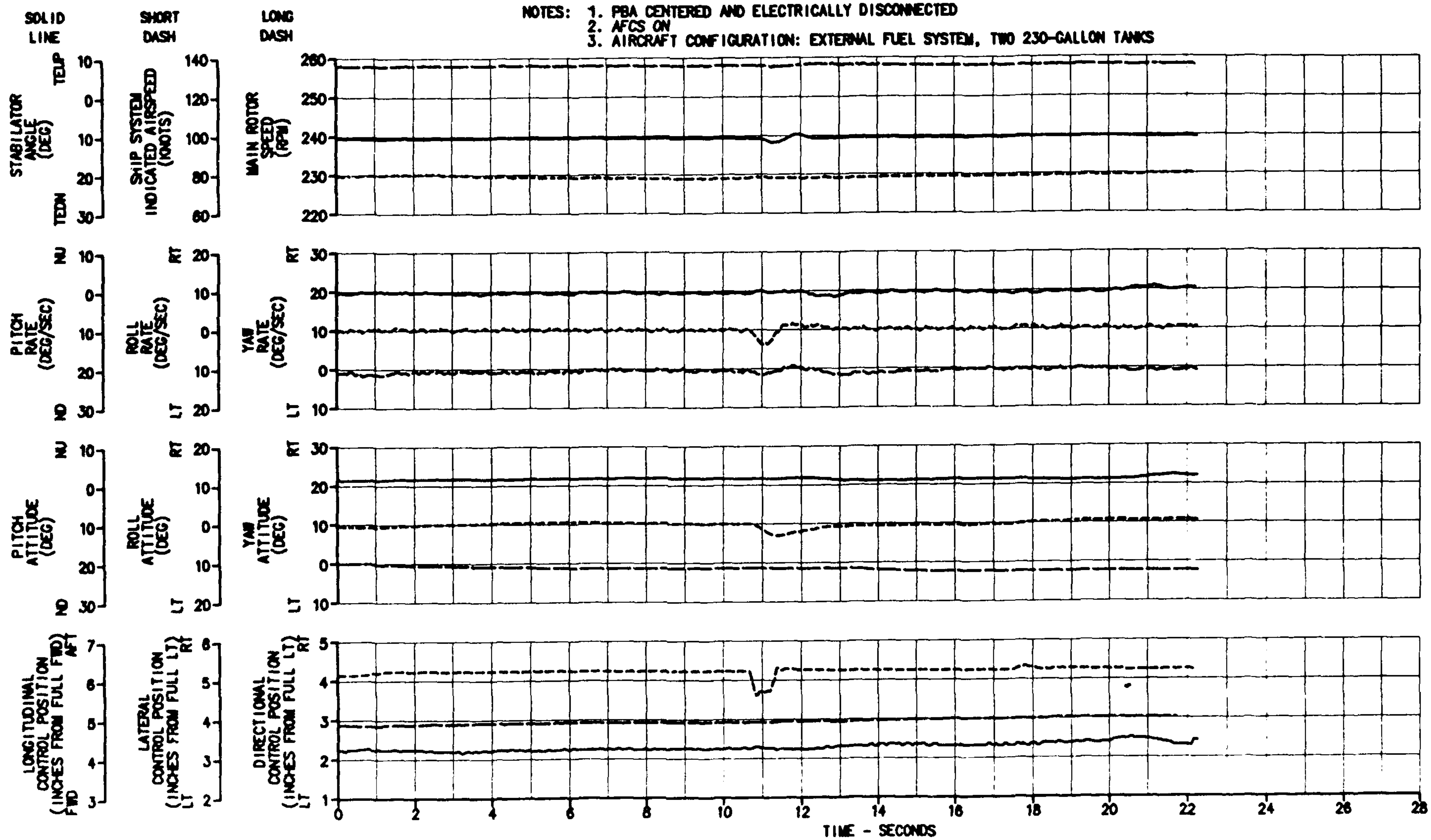


FIGURE E-36
LEFT LATERAL PULSE INPUT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19460	360.3(AFT)	0.0	5960	23.0	258	77	AUTOROTATION

NOTES:
1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

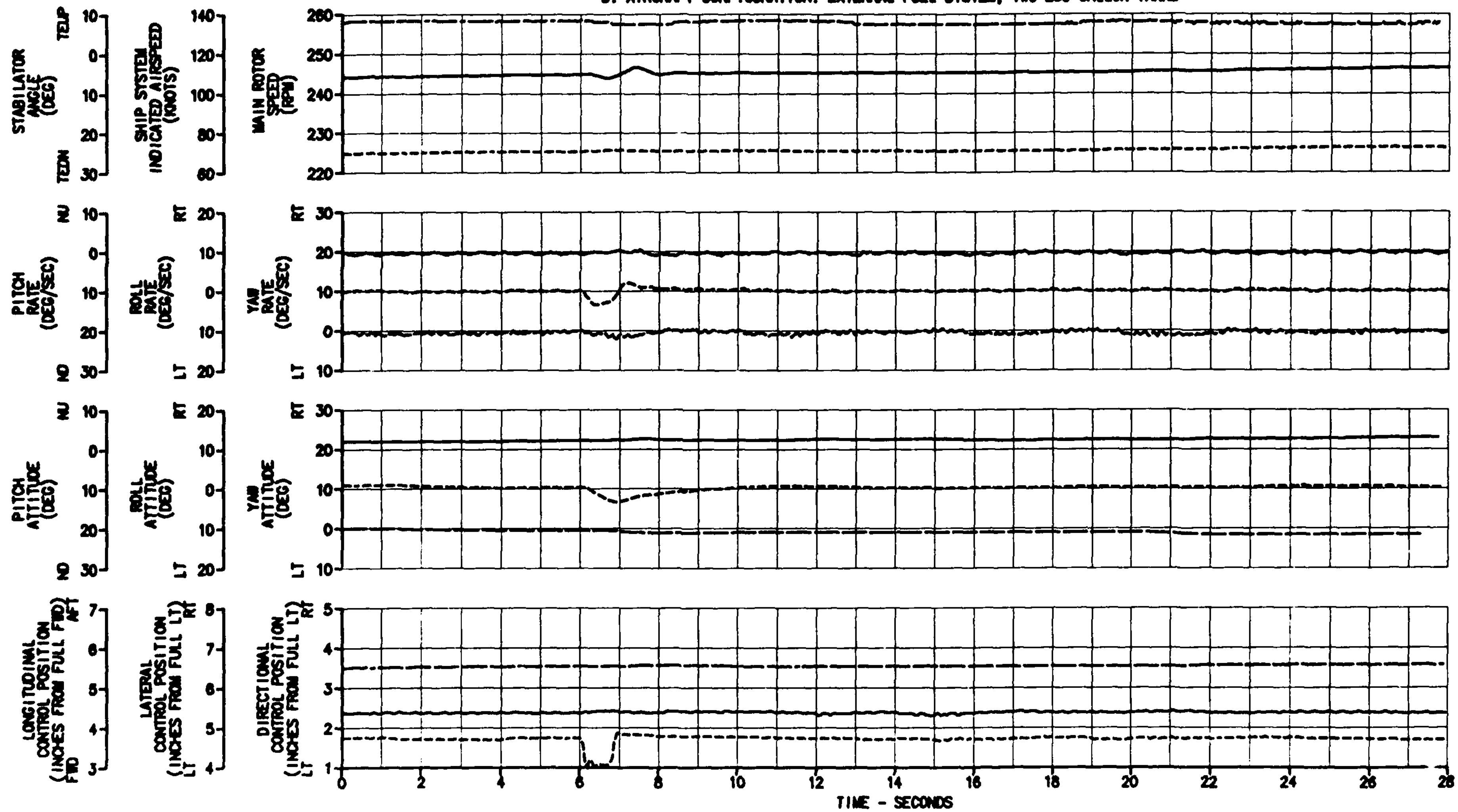


FIGURE E-37
LEFT DIRECTIONAL PULSE INPUT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19380	361.0(AFT)	0.0	6480	22.0	258	79	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

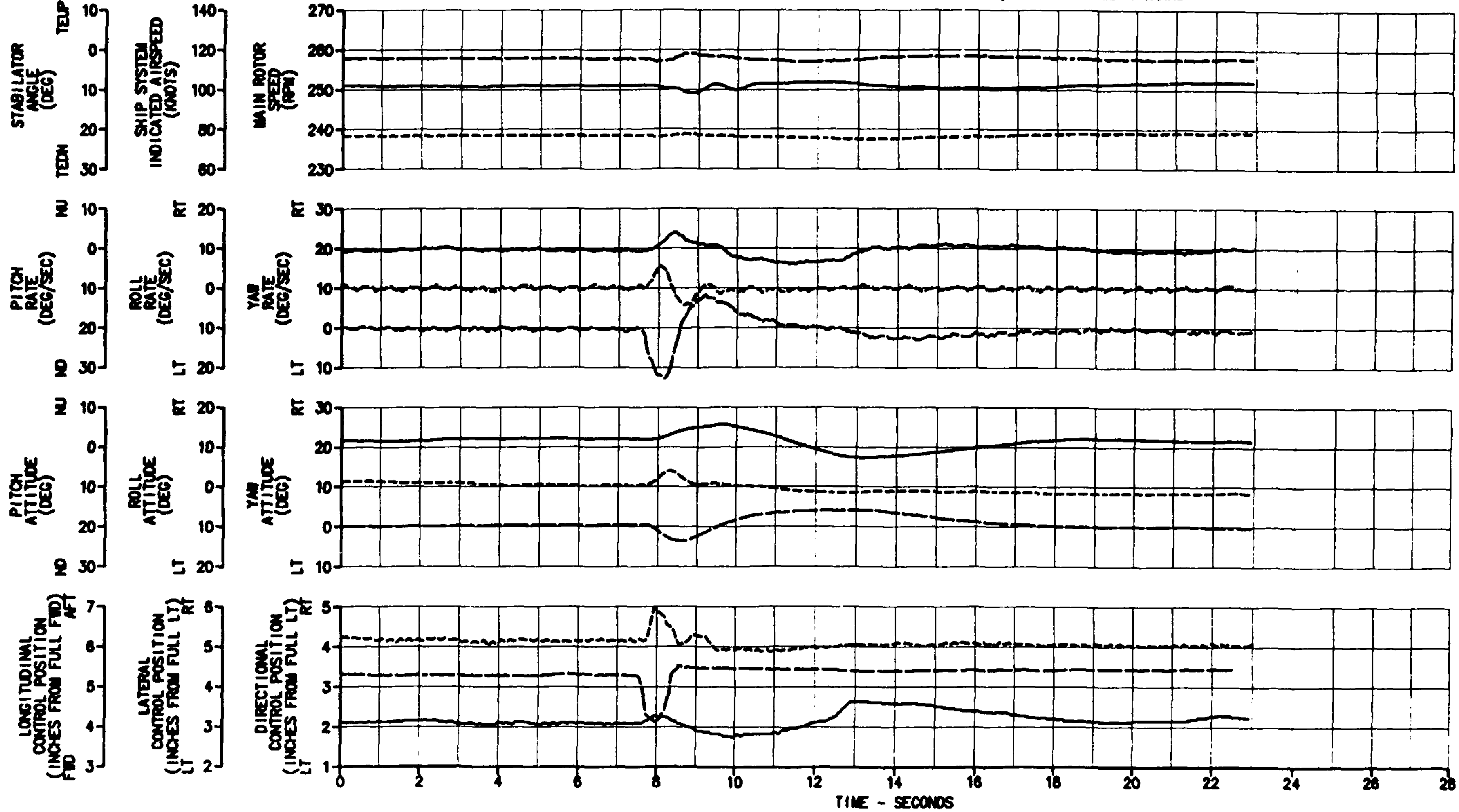


FIGURE E-38
RIGHT DIRECTIONAL PULSE INPUT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
18770	360.8(AFT)	0.0	6500	24.0	258	132	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

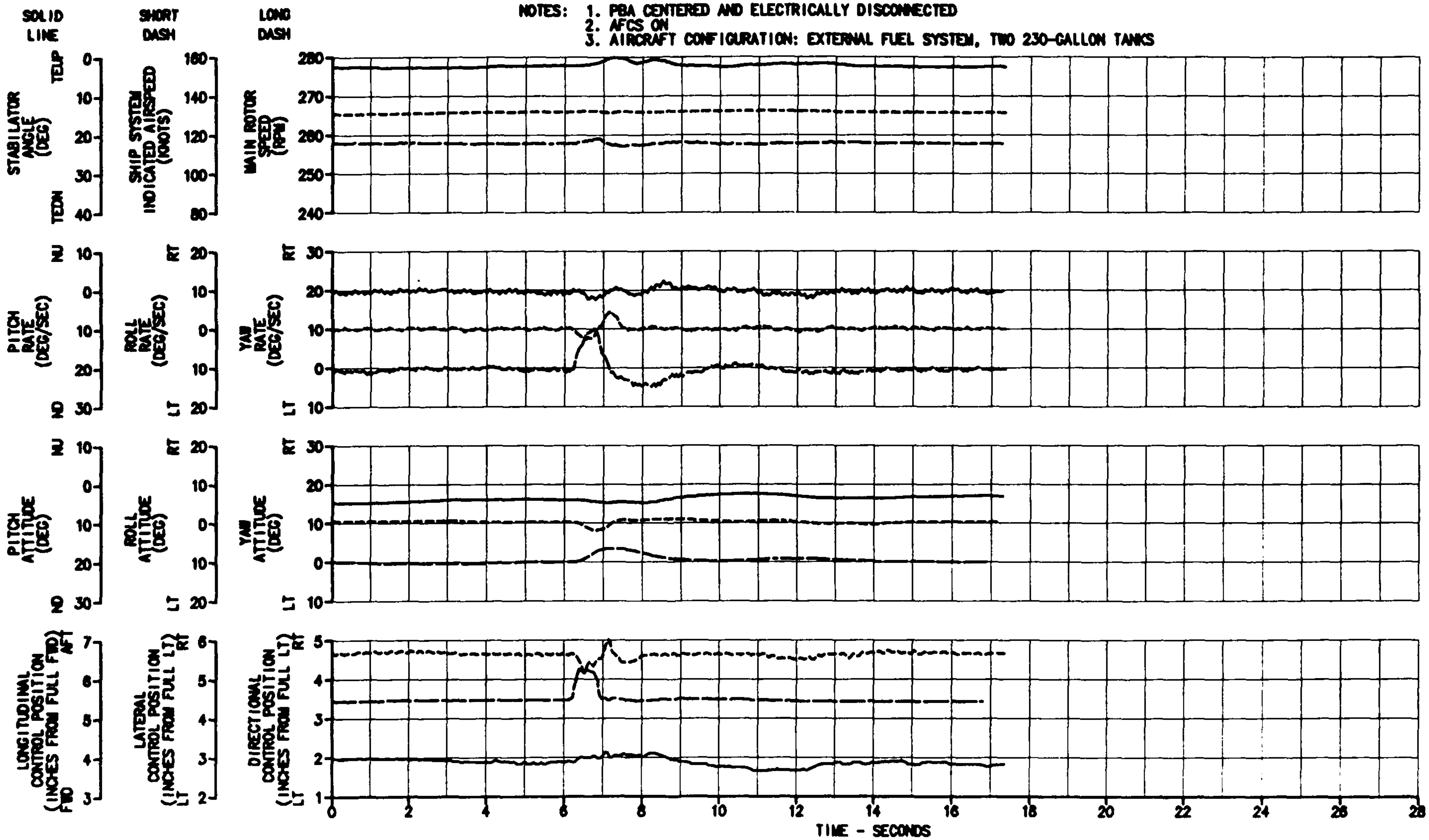


FIGURE E-30

RIGHT DIRECTIONAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19210	360.0(AFT)	0.0	5690	25.0	258	79	IRP CLIMB

NOTES:
1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

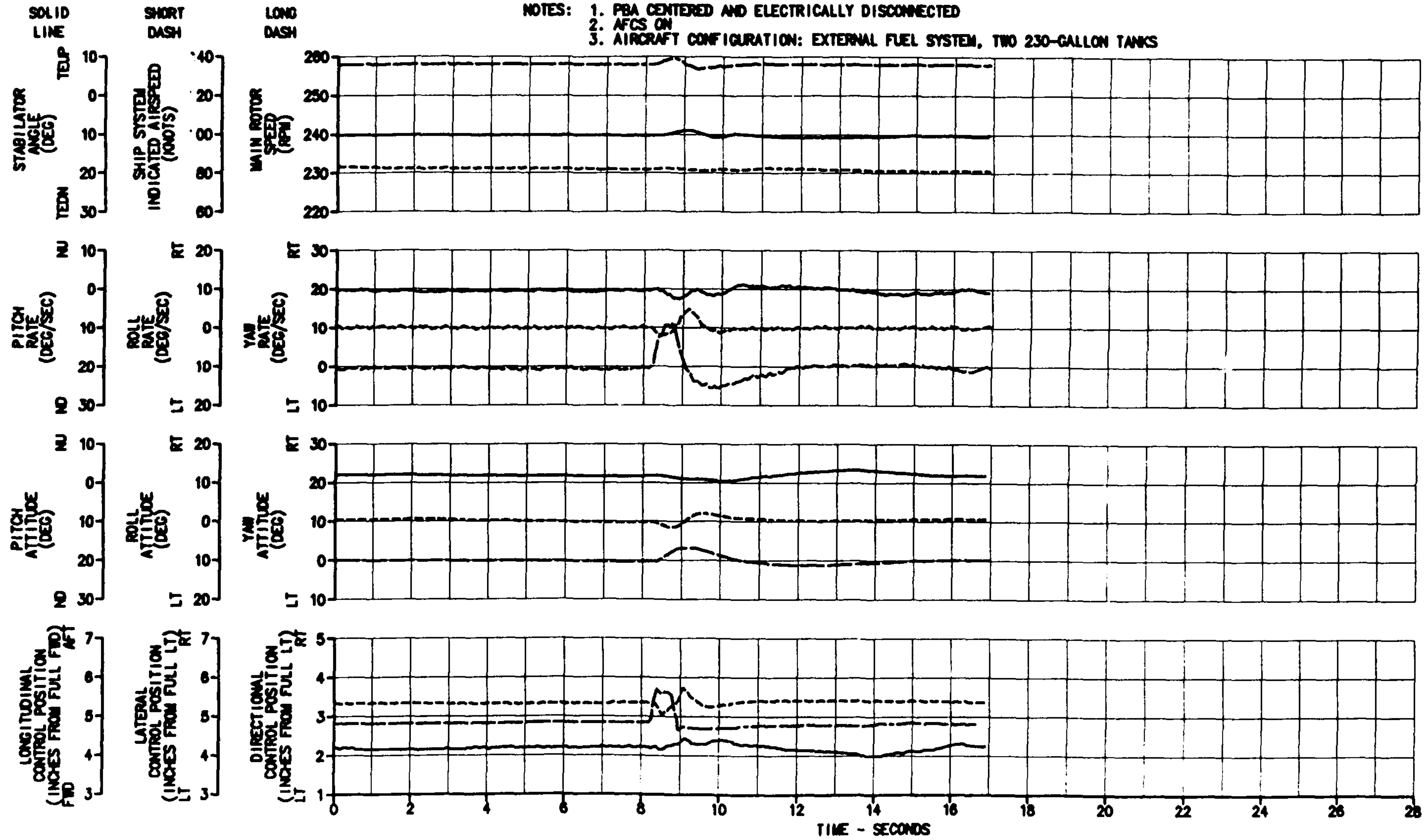


FIGURE E-40

LEFT DIRECTIONAL PULSE INPUT

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19230	380.1(AFT)	0.0	5050	23.0	258	78	AUTOROTATION

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

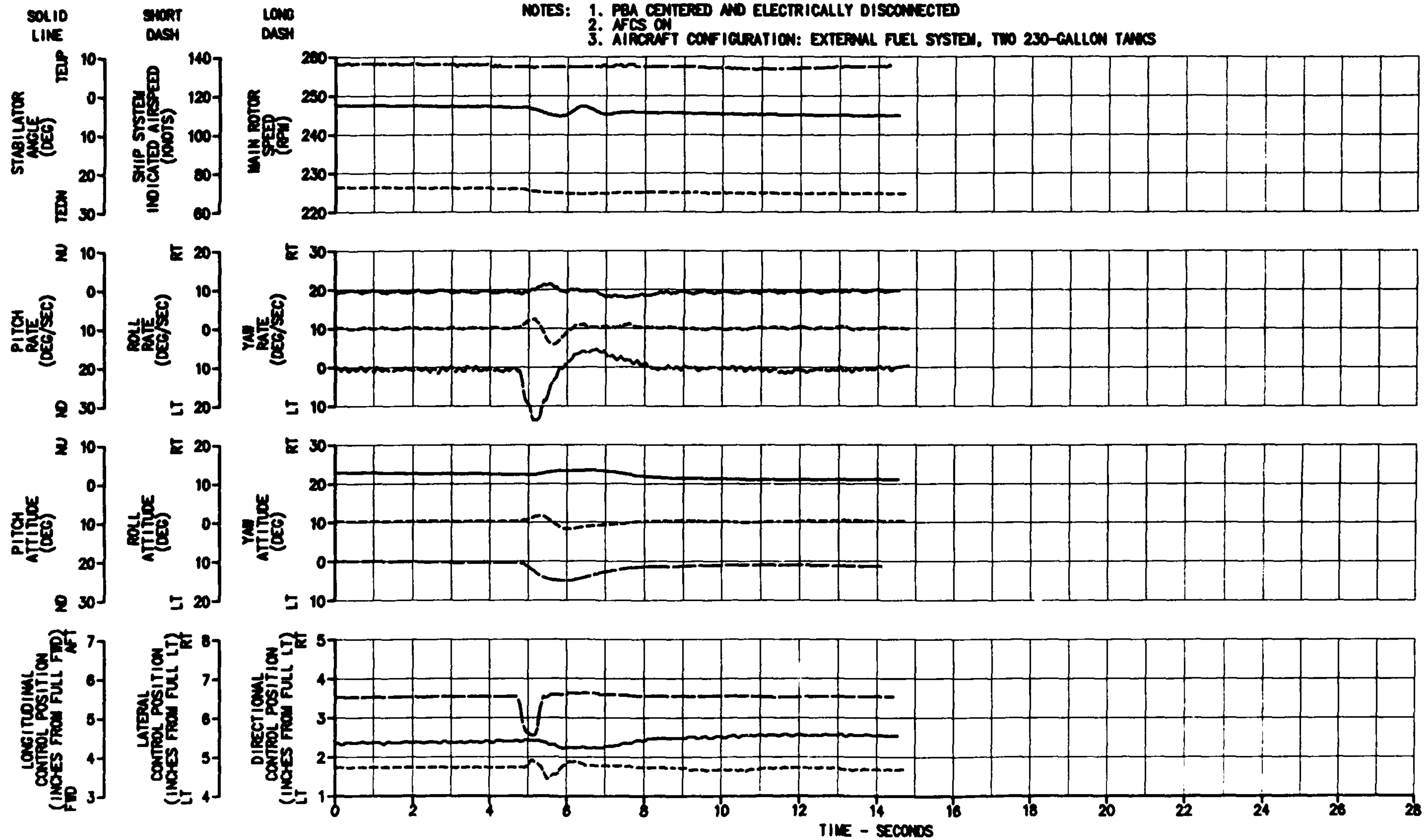


FIGURE E-41
RELEASE FROM LEFT SIDESLIP
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19230	360.9(AFT)	0.0	6560	22.0	258	78	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

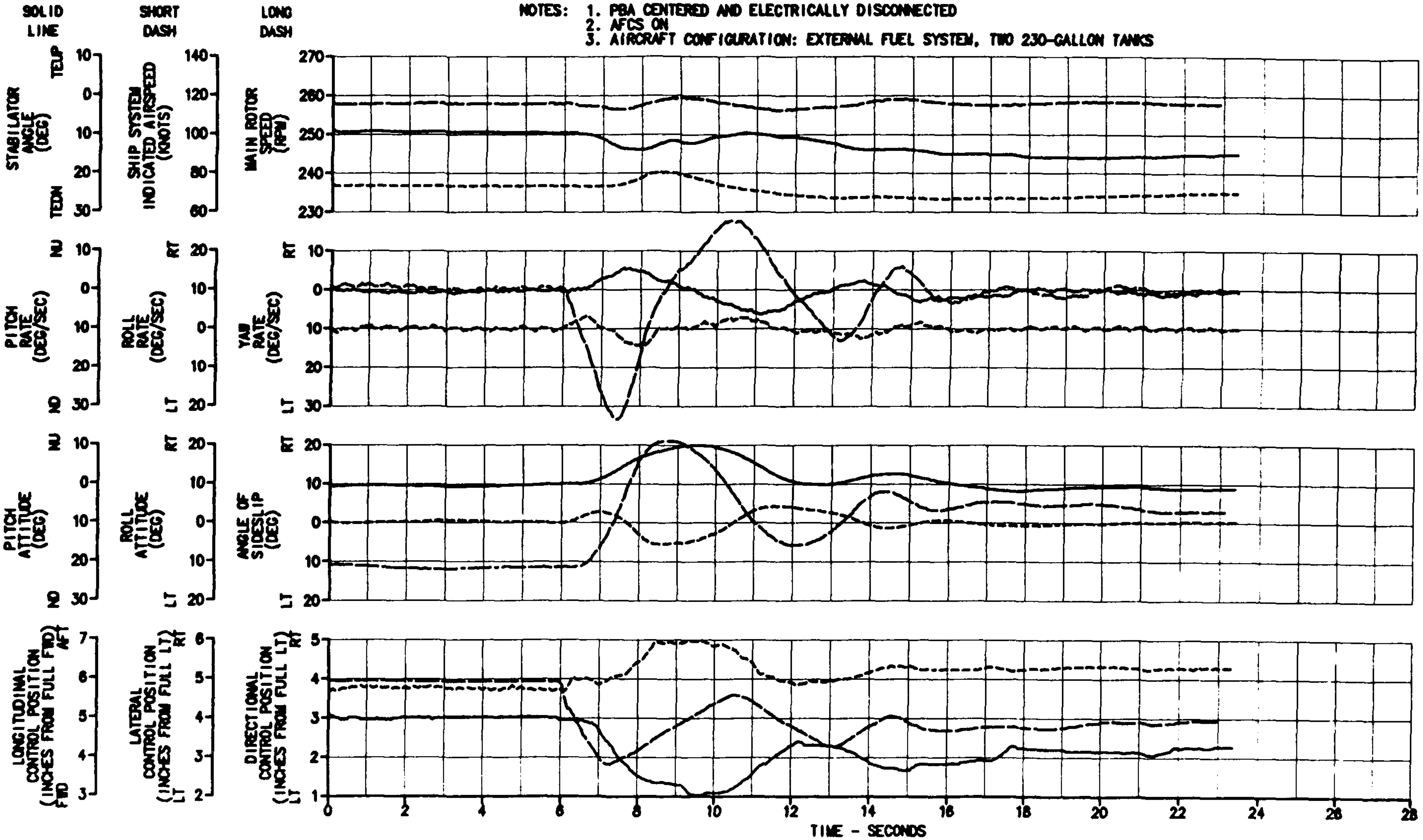


FIGURE E-42

RELEASE FROM RIGHT SIDESLIP

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19280	361.0(AFT)	0.0	6380	22.5	258	78	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

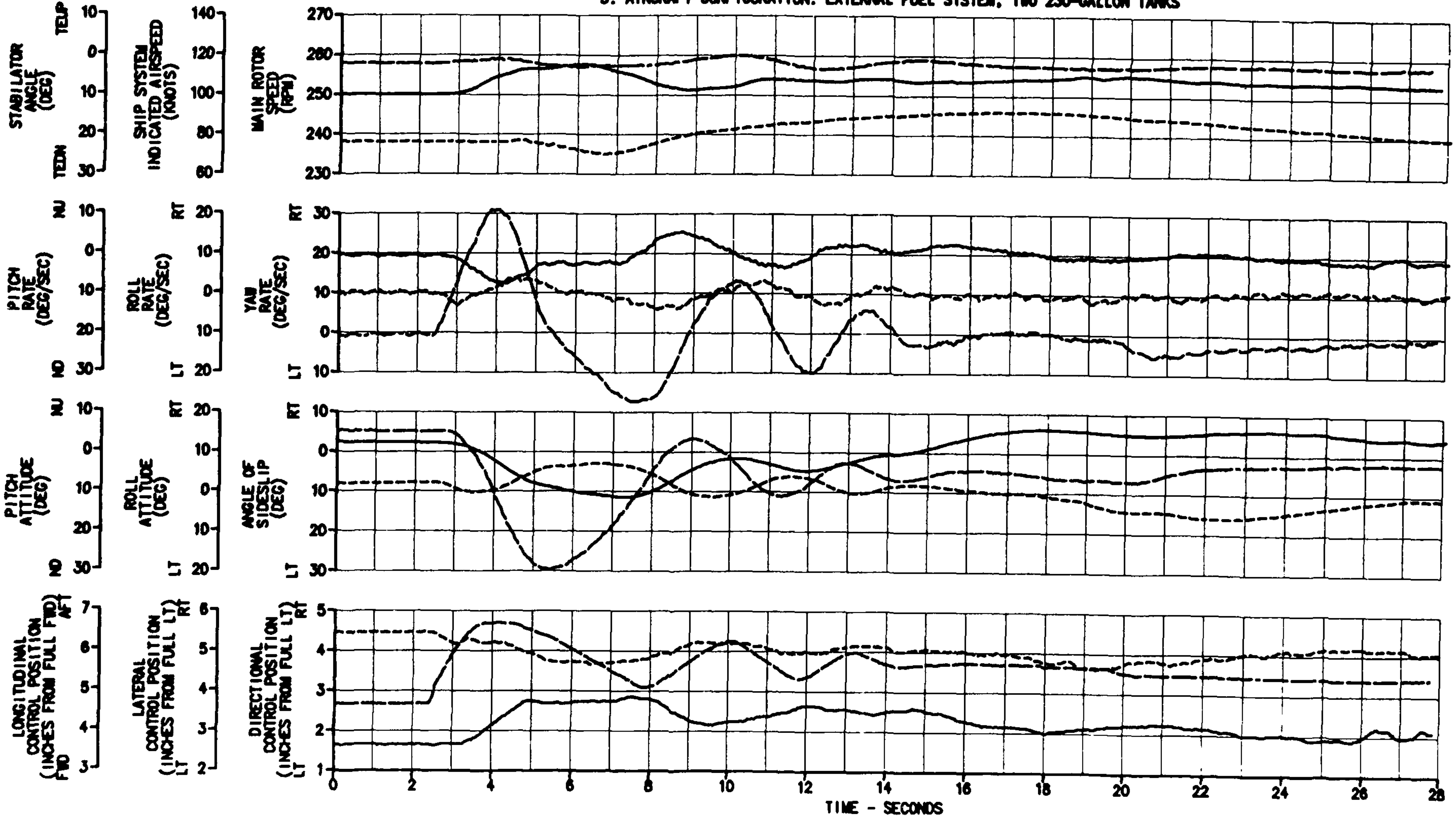


FIGURE E-43

RELEASE FROM LEFT SIDESLIP

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
18710	381.0(AFT)	0.0	6360	24.0	258	132	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

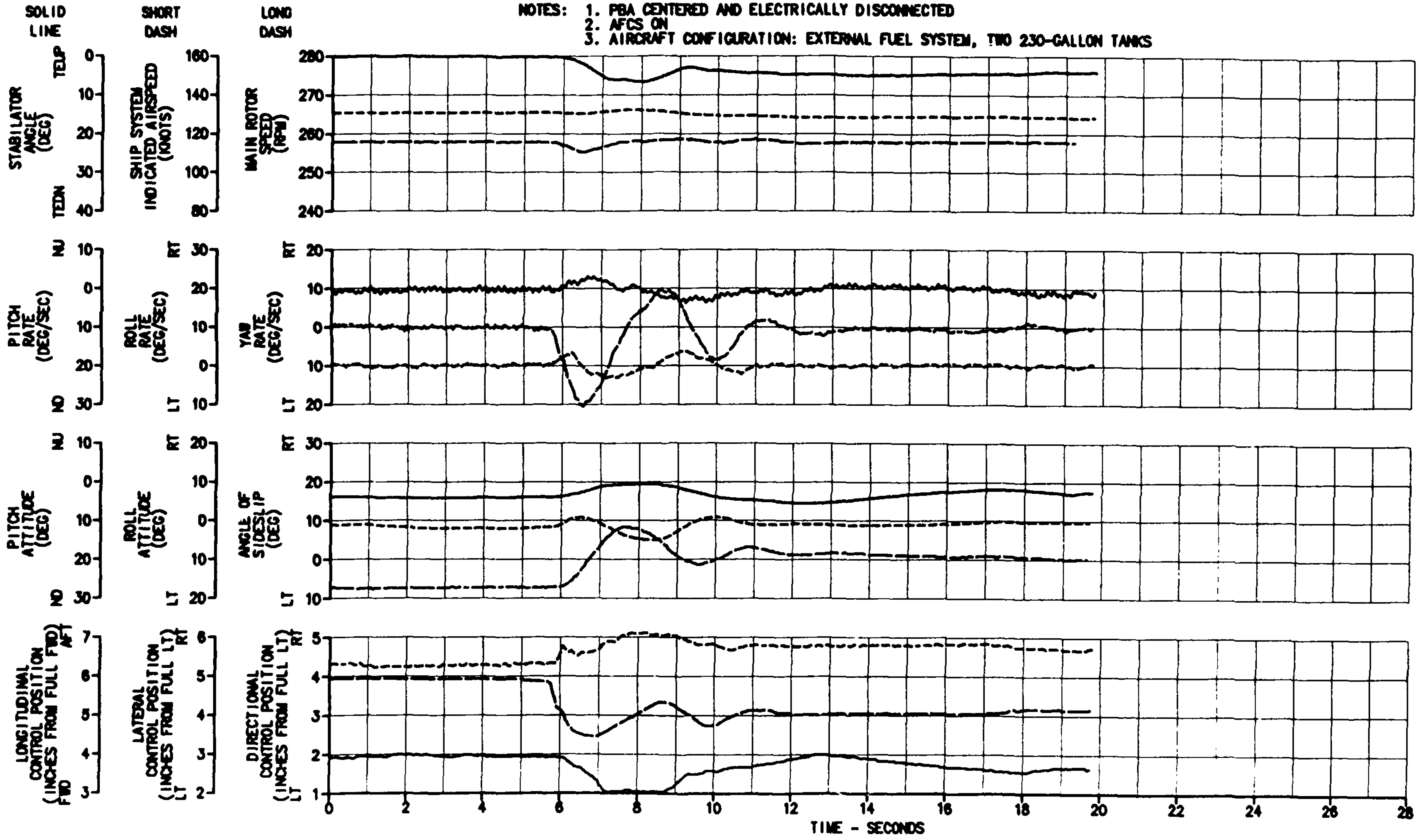


FIGURE E-44
RELEASE FROM RIGHT SIDESLIP
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
18680	360.9(AFT)	0.0	6450	24.0	258	134	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

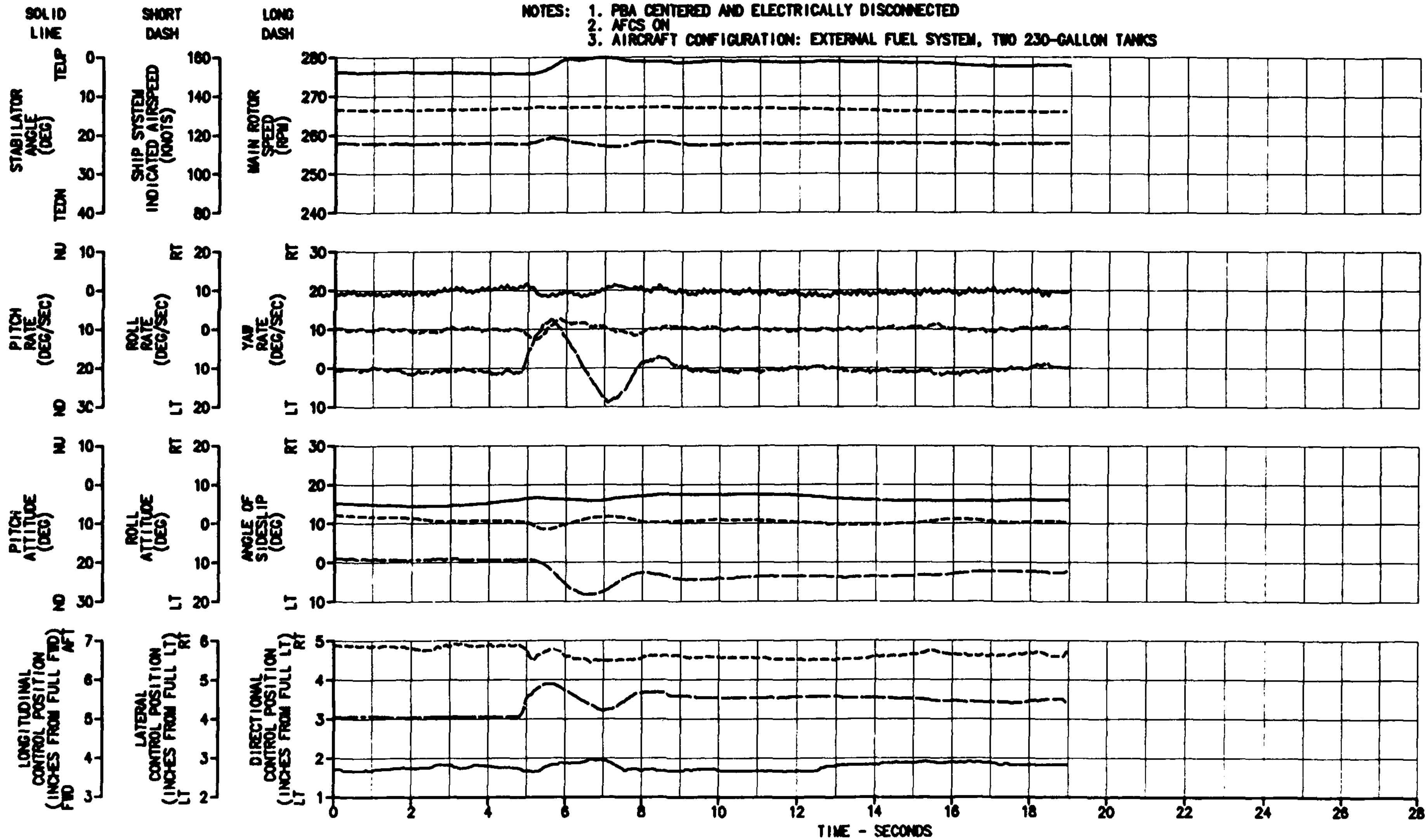


FIGURE E-45
RELEASE FROM LEFT SIDESLIP
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19130	360.3(AFT)	0.0	6420	23.0	258	80	IRP CLIMB

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

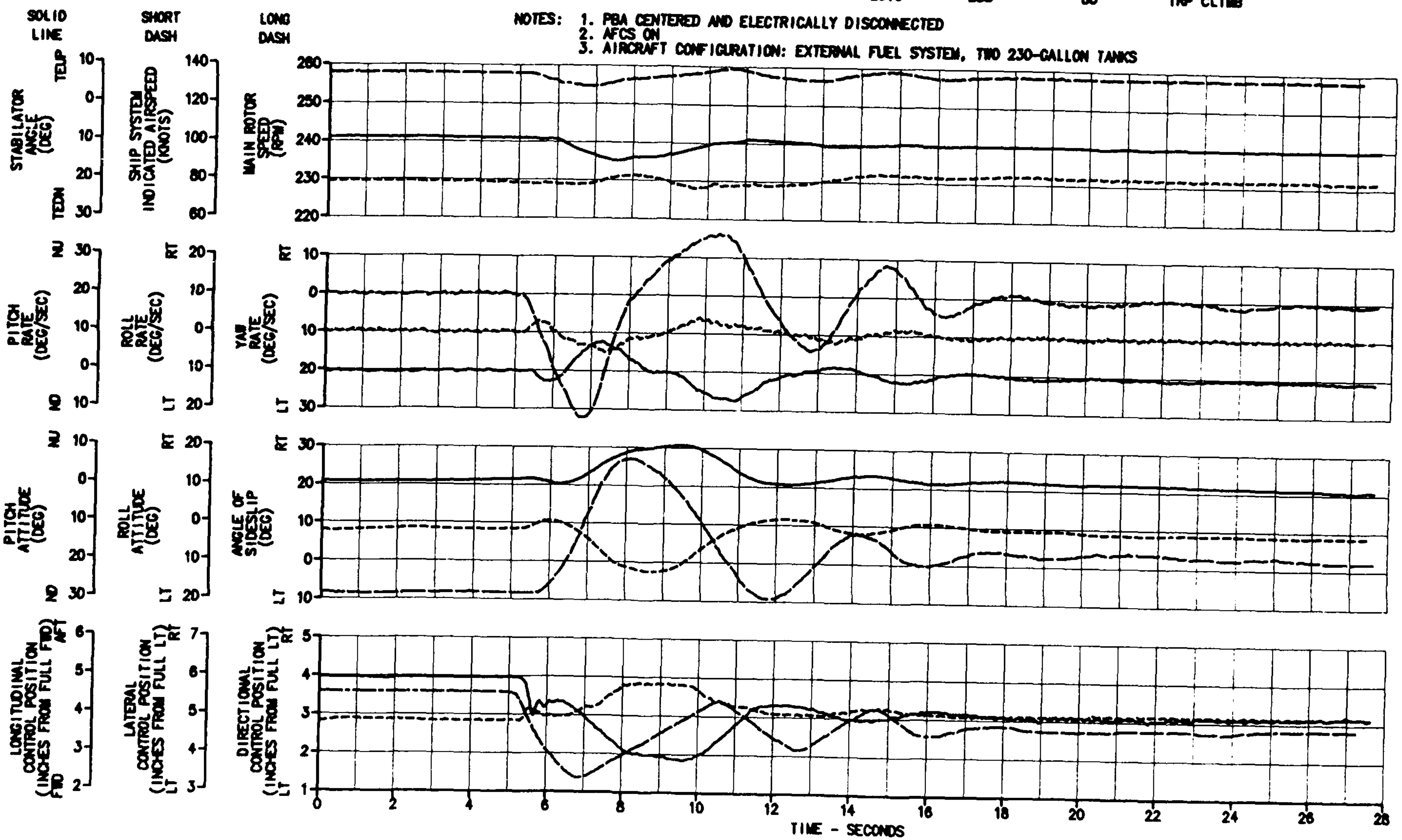


FIGURE E-48

RELEASE FROM RIGHT SIDESLIP

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
18910	360.3(AFT)	0.0	6530	22.0	258	78	IRP CLIMB

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

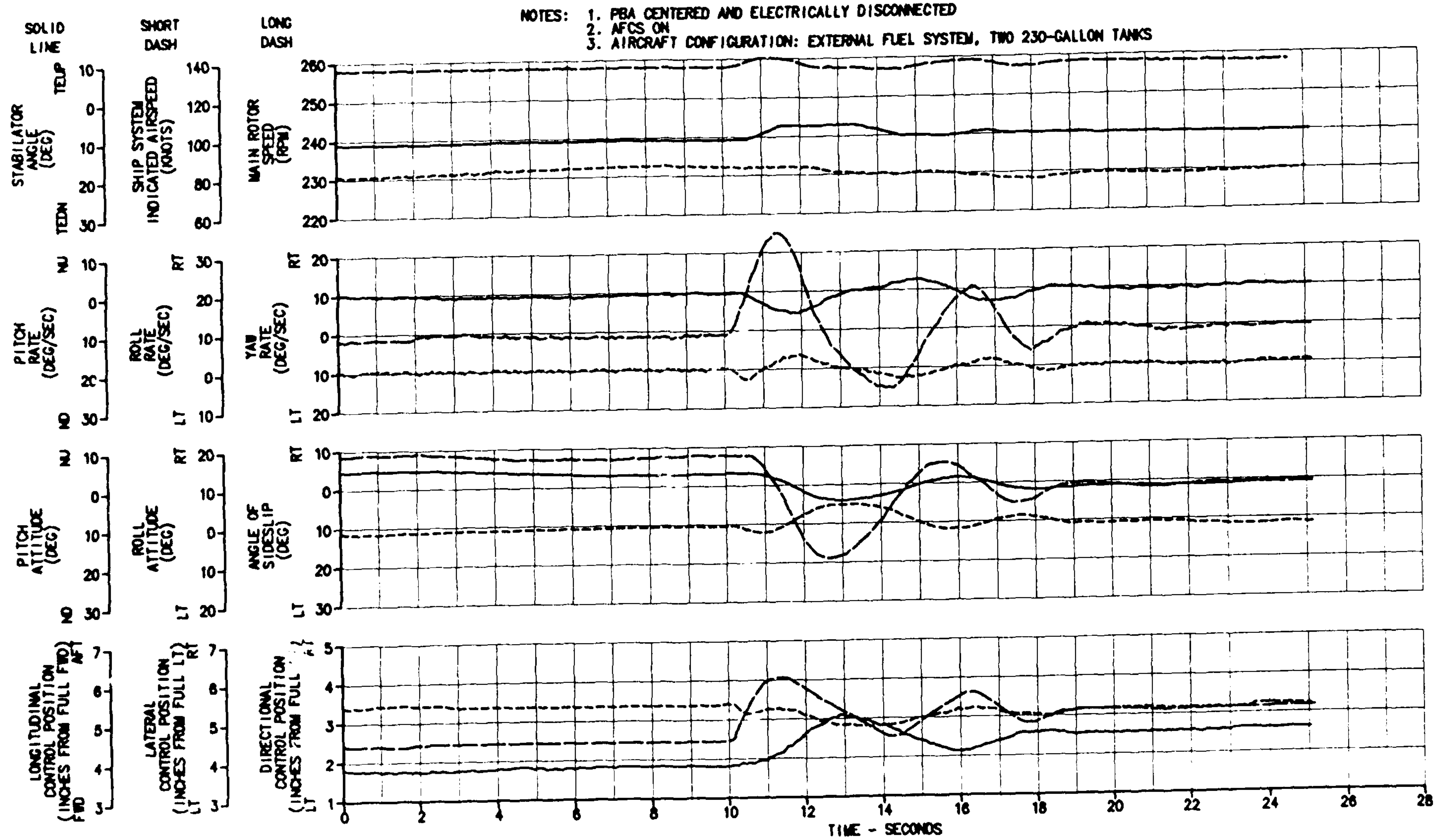


FIGURE E-47

RELEASE FROM LEFT SIDESLIP

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19090	360.2(AFT)	0.0	6800	21.0	259	79	AUTOROTATION

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

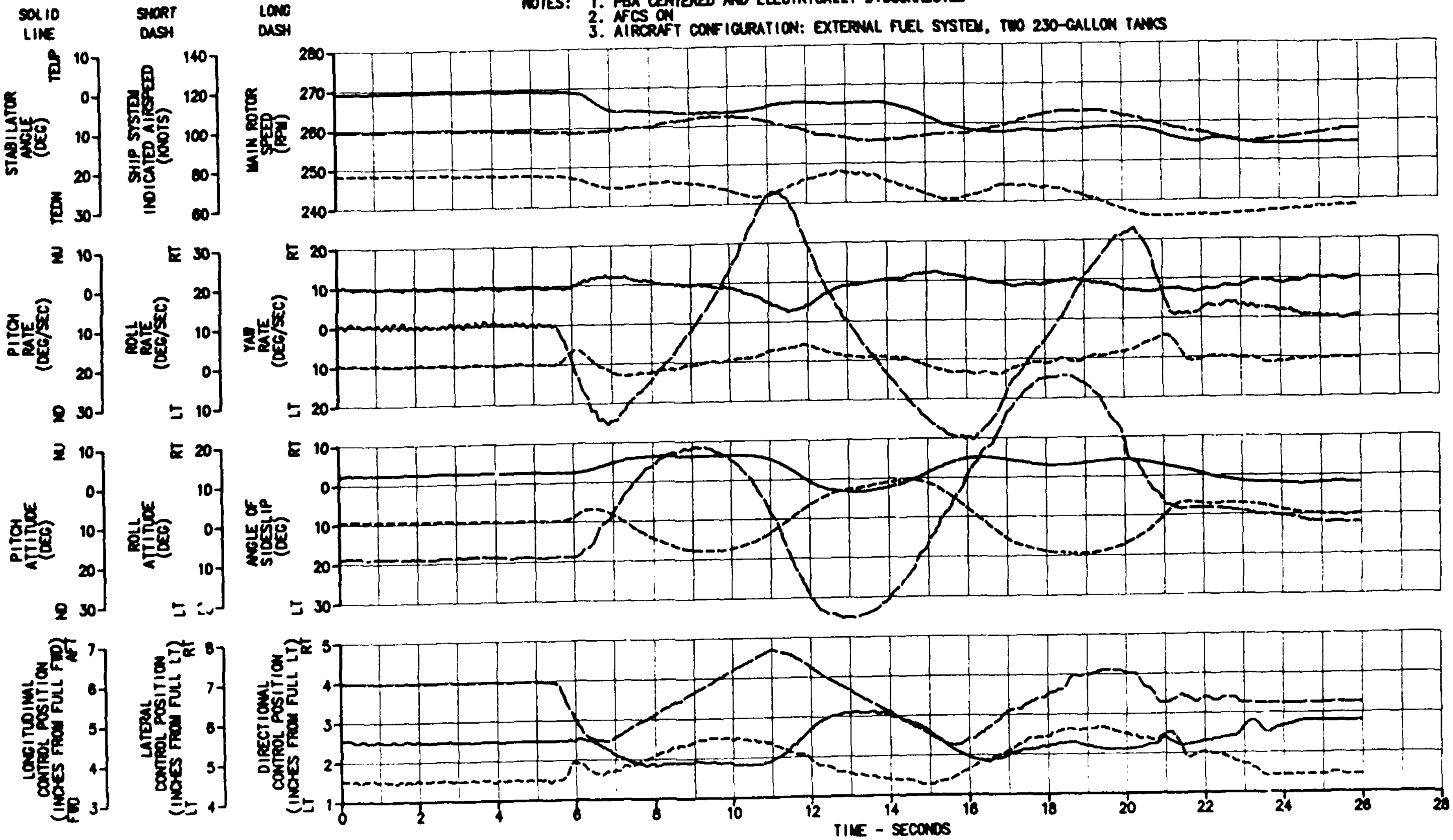


FIGURE E-48

RELEASE FROM RIGHT SIDESLIP

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19000	360.1(AFT)	0.0	7240	20.0	260	78	AUTOROTATION

NOTES:
1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

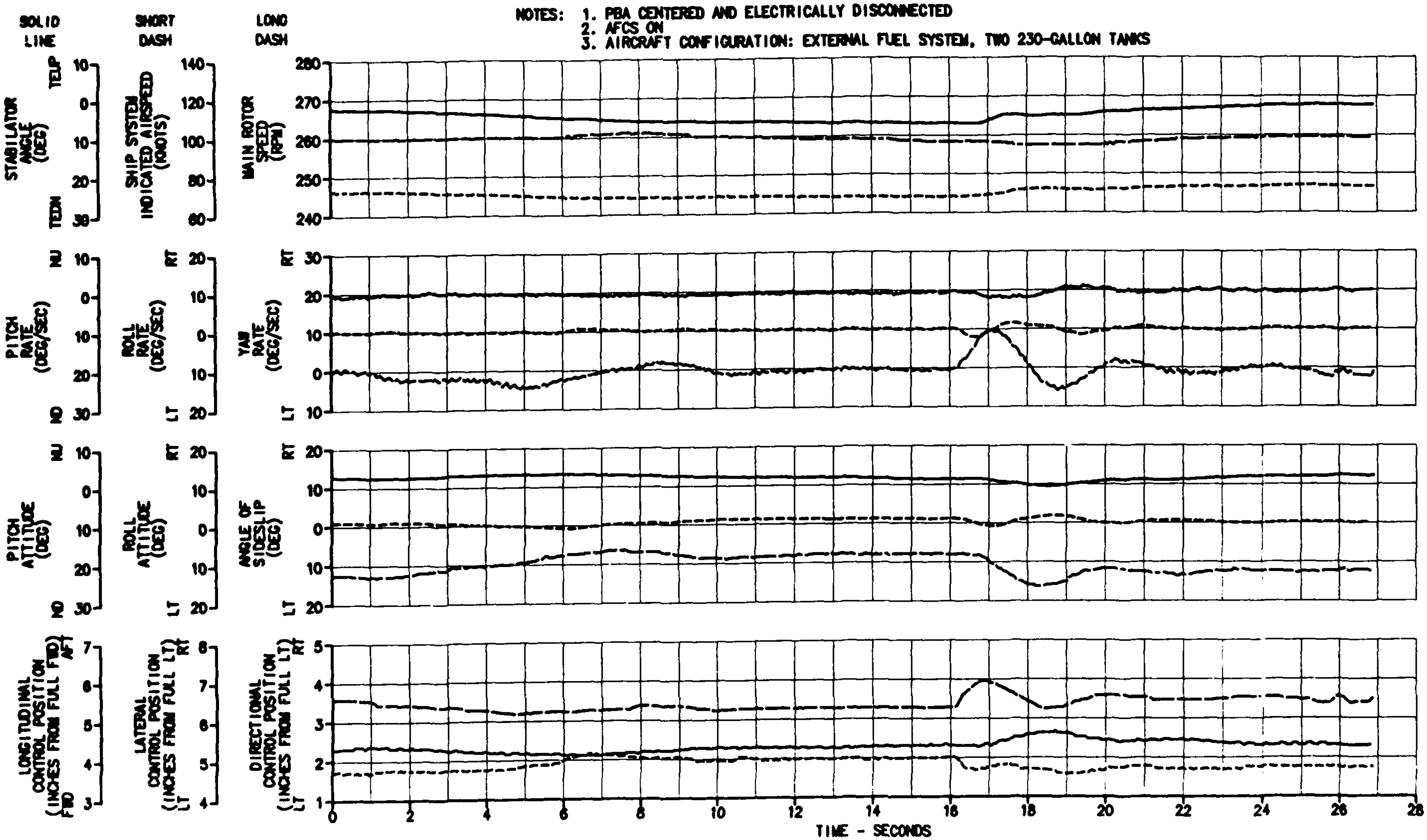


FIGURE E-49

LONGITUDINAL LONG-TERM RESPONSE

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
19140	360.7(AFT)	0.0	6540	22.0	258	79	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

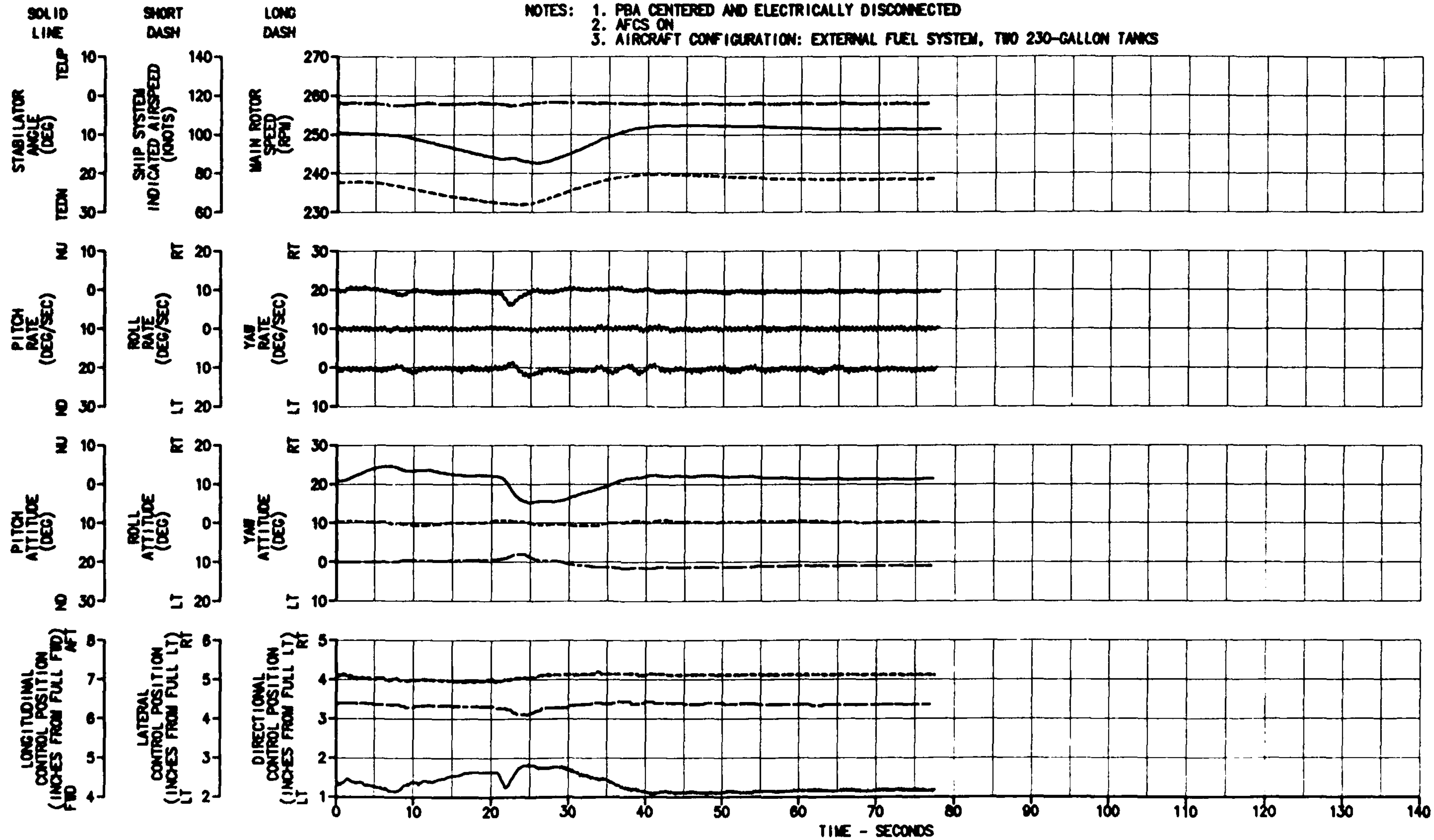


FIGURE E-50

LONGITUDINAL LONG-TERM RESPONSE

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
18630	361.0(AFT)	0.0	6440	24.0	258	133	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

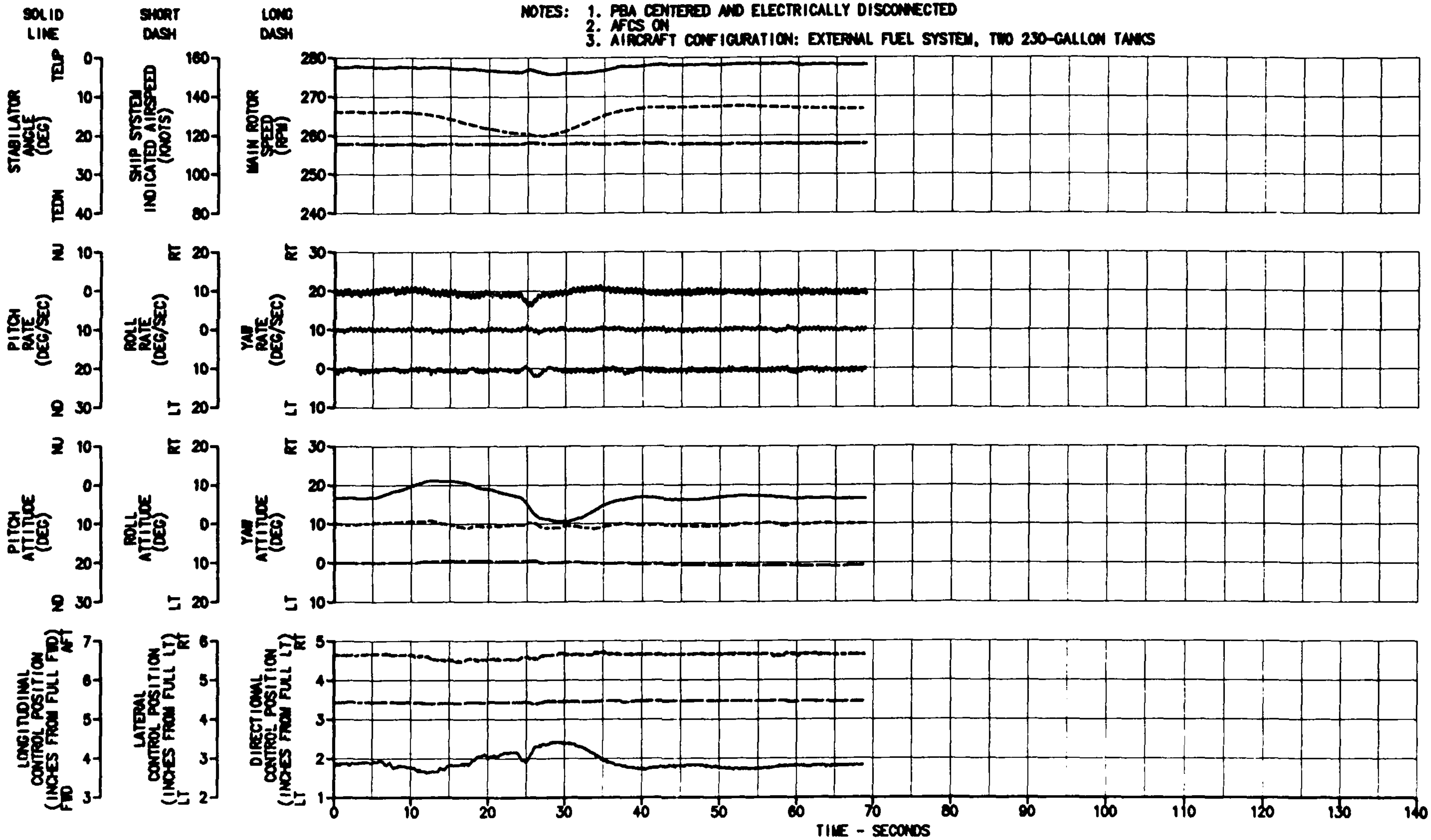


FIGURE E-51

RESPONSE TO SIMULATED ENGINE FAILURE

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
18550	360.9(AFT)	0.0	6400	24.0	258	132	LEVEL

NOTES: 1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

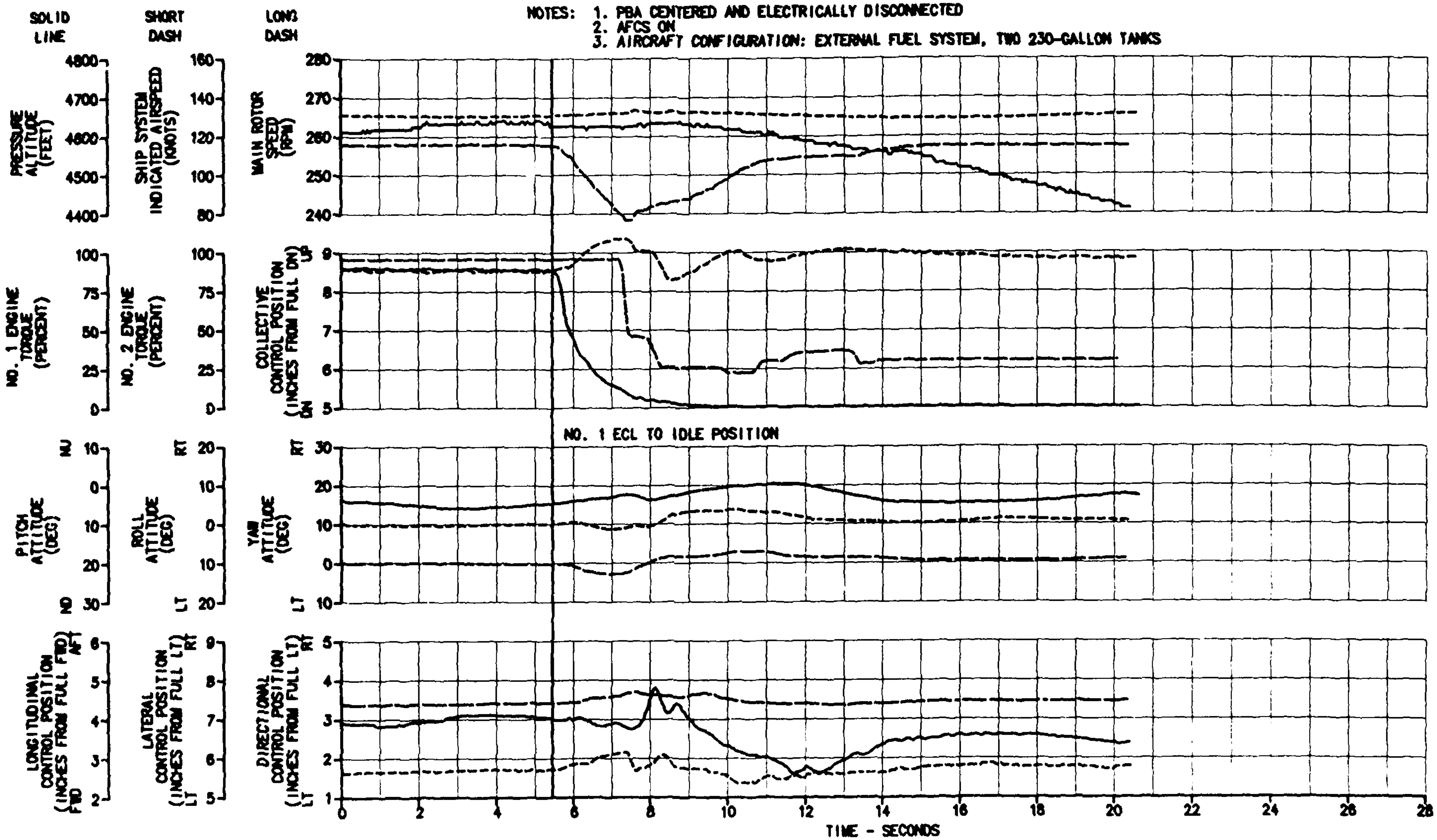


FIGURE E-52

RESPONSE TO SIMULATED ENGINE FAILURE

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KNOTS)	TRIM FLIGHT CONDITION
18980	360.2(AFT)	0.0	6080	23.0	258	80	IRP CLIMB

NOTES:
1. PBA CENTERED AND ELECTRICALLY DISCONNECTED
2. AFCS ON
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

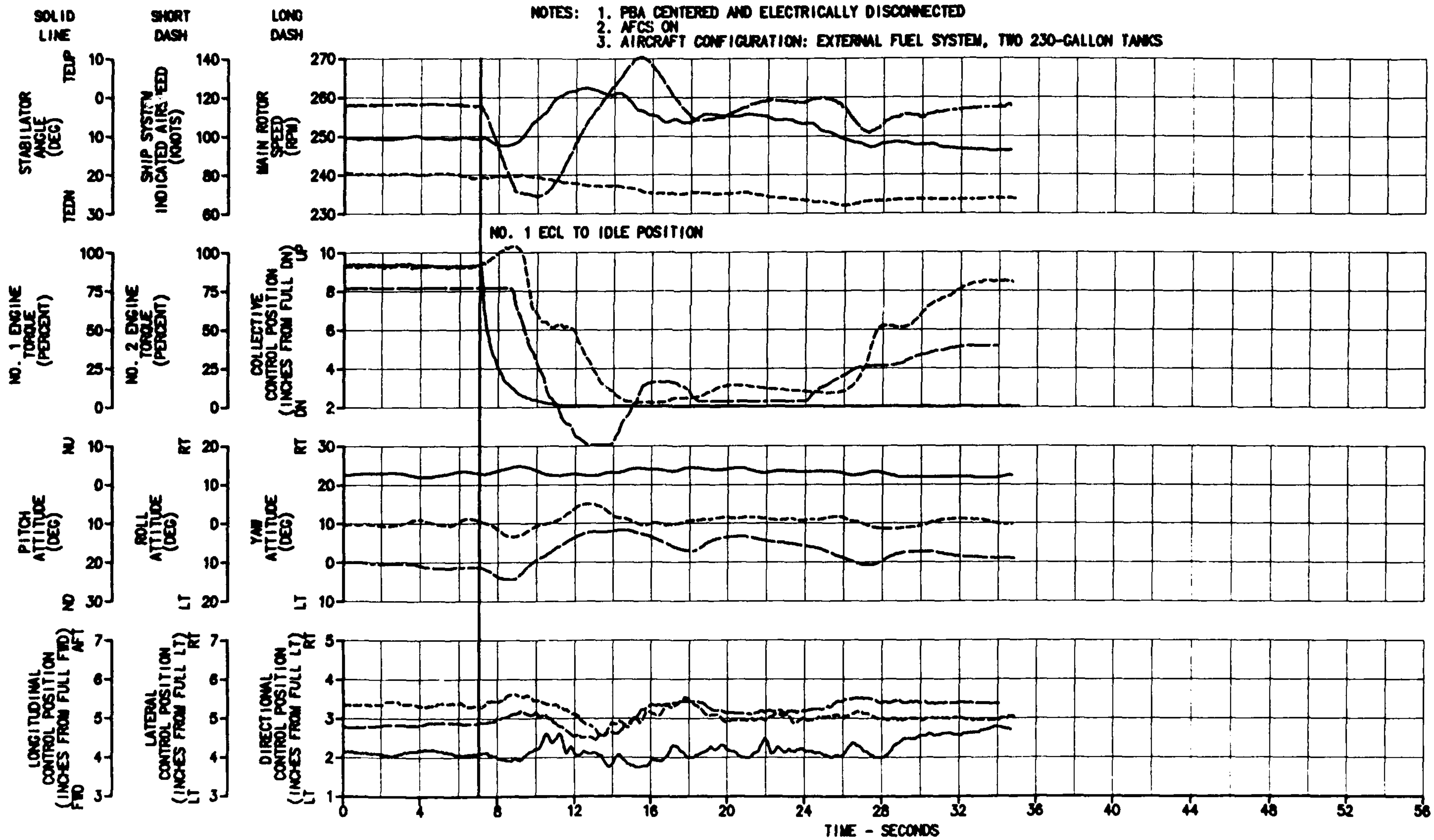


FIGURE E-53
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

LATERAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
17390	348.1(FWD)	0.0	4690	18.5	260

	PARAMETER	LOCATION FS	BL	WL
○	PILOT STATION	232.0	24.5	208.0
△	AIRCRAFT CABIN	387.0	7.0 RT	215.0

NOTES: 1. MAIN ROTOR FUNDAMENTAL FREQUENCY = 4.3 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

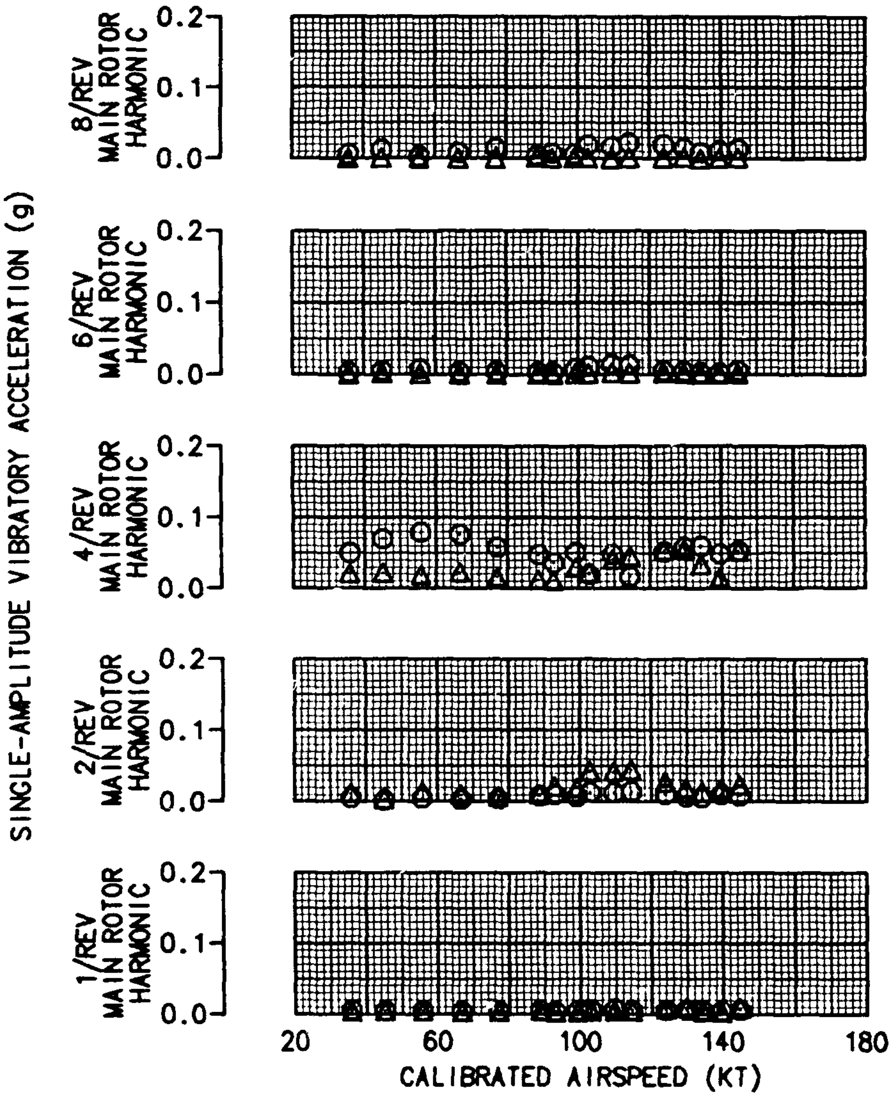


FIGURE E-54
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

LATERAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
18630	347.2(FWD)	0.0	9010	4.0	253

	PARAMETER	LOCATION FS	BL	WL
ʘ	PILOT STATION	232.0	24.5	208.0
Δ	AIRCRAFT CABIN	387.0	7.0 RT	215.0

NOTES: 1. MAIN ROTOR FUNDAMENTAL FREQUENCY = 4.2 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

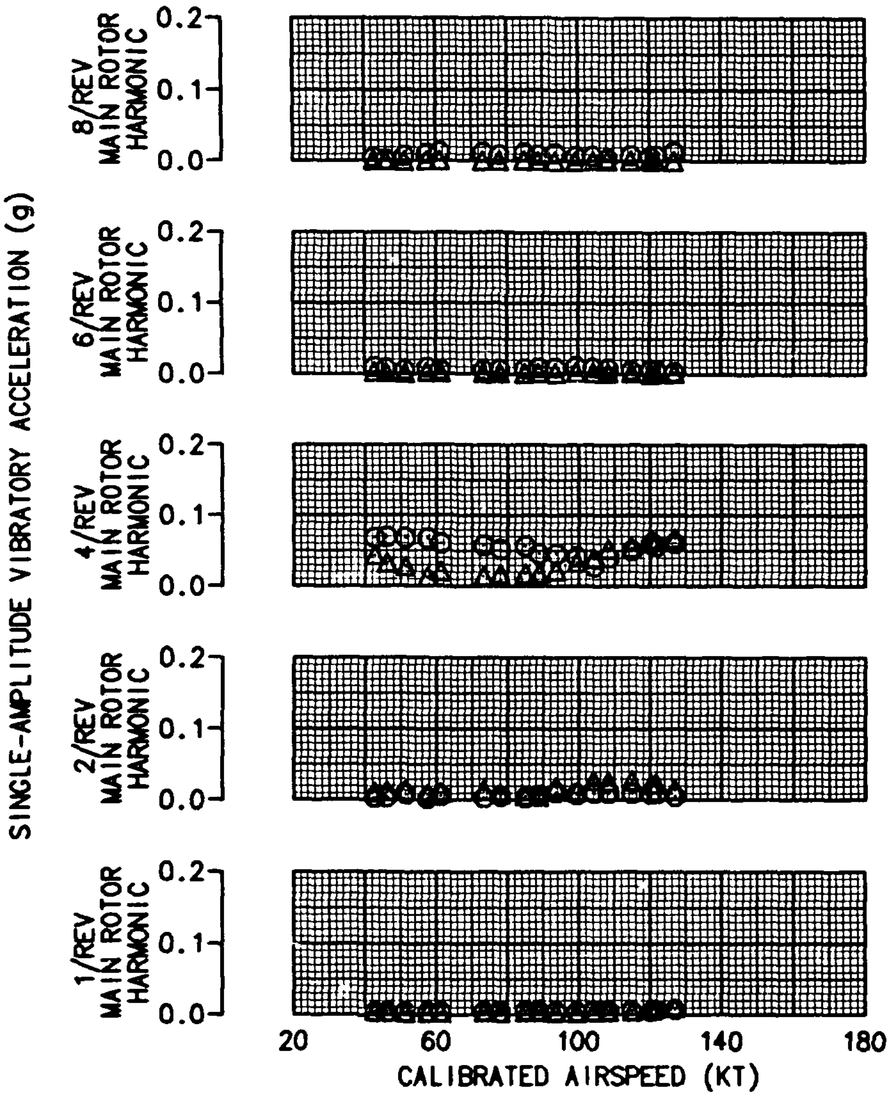


FIGURE E-55
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

LONGITUDINAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
17390	348.1(FWD)	0.0	4690	18.5	260

	PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
⊙	PILOT STATION	232.0	24.5	208.0
△	AIRCRAFT CABIN	387.0	7.0 RT	215.0

NOTES: 1. MAIN ROTOR FUNDAMENTAL FREQUENCY = 4.3 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

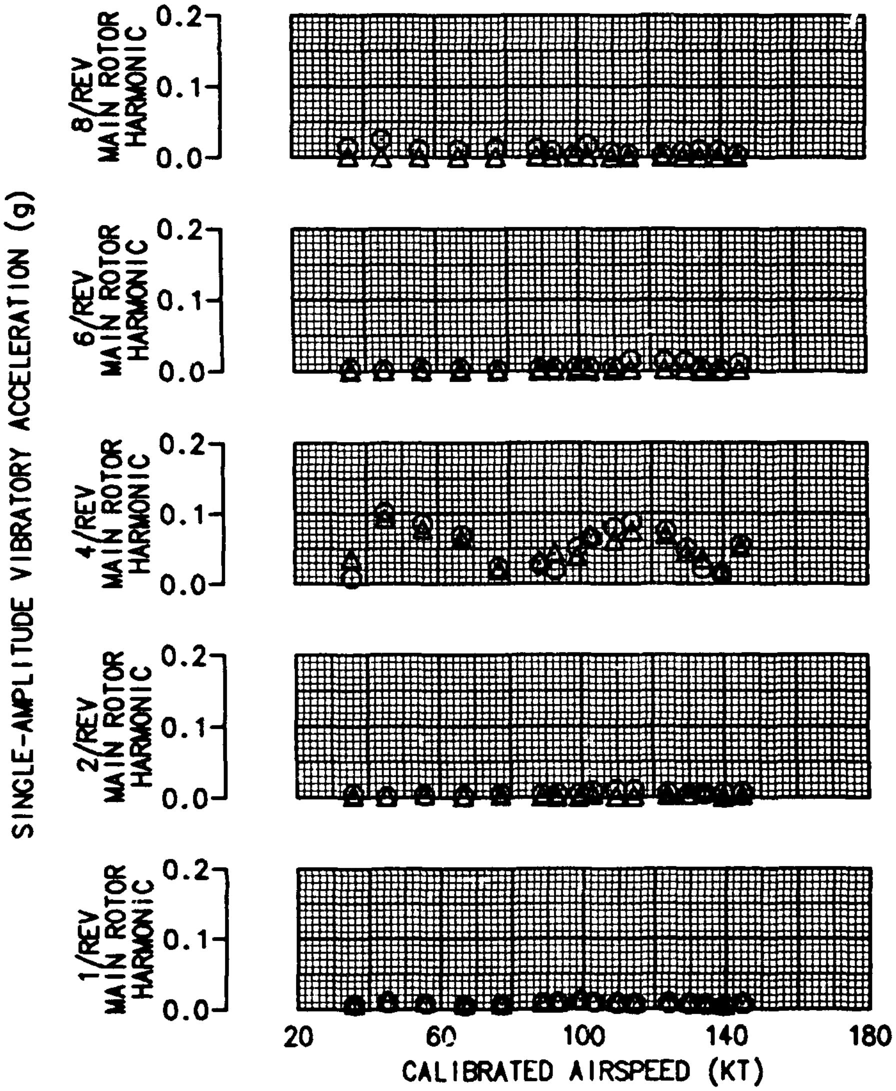


FIGURE E-56

VIBRATION CHARACTERISTICS IN LEVEL FLIGHT

UH-60A USA S/N 82-23748

LONGITUDINAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
18630	347.2(FWD)	0.0	9010	4.0	253

	PARAMETER	LOCATION FS	BL	WL
⊙	PILOT STATION	232.0	24.5	208.0
Δ	AIRCRAFT CABIN	387.0	7.0 RT	215.0

NOTES: 1. MAIN ROTOR FUNDAMENTAL FREQUENCY = 4.2 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

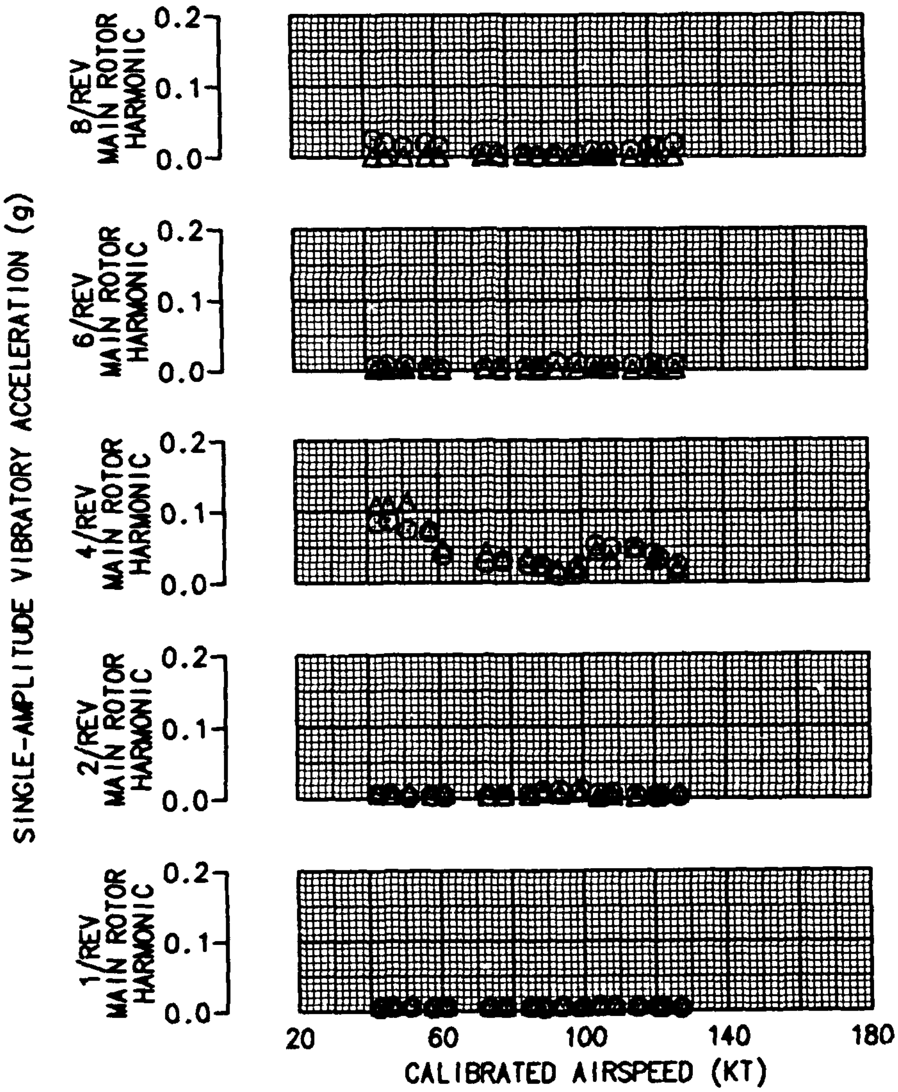


FIGURE E-57
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

VERTICAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
17390	348.1(FWD)	0.0	4690	18.5	260

	PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
⊙	PILOT STATION	232.0	24.5	208.0
△	AIRCRAFT CABIN	387.0	7.0 RT	215.0

NOTES: 1. MAIN ROTOR FUNDAMENTAL FREQUENCY = 4.3 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

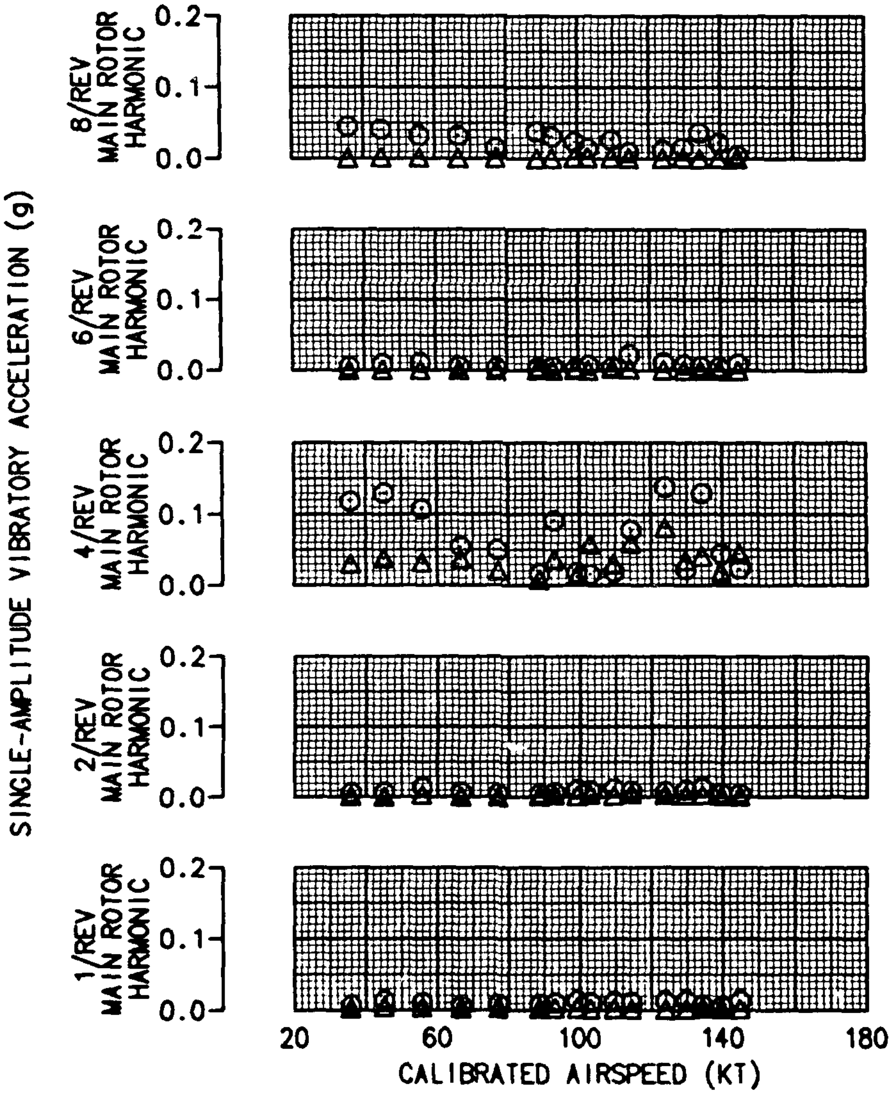


FIGURE E-58
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

VERTICAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
18630	347.2(FWD)	0.0	9010	4.0	253

	PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
⊙	PILOT STATION	232.0	24.5	208.0
Δ	AIRCRAFT CABIN	387.0	7.0 RT	215.0

NOTES: 1. MAIN ROTOR FUNDAMENTAL FREQUENCY = 4.2 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

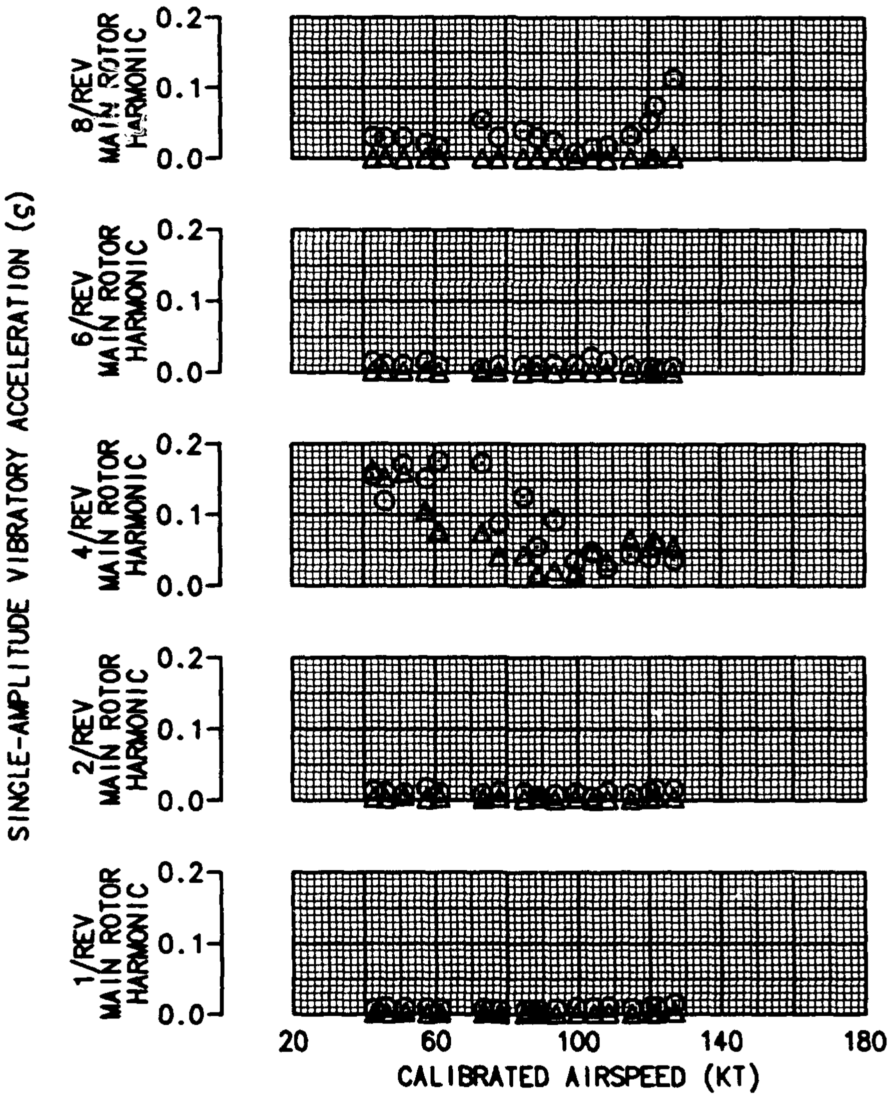


FIGURE E-59
VIBRATION CHARACTERISTICS IN TURNING FLIGHT
UH-60A USA S/N 82-23748

LATERAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	AVG CALIBRATED AIRSPEED (KT)
19540	361.0(AFT)	0.0	6060	16.0	258	79
18880	360.9(AFT)	0.0	6380	16.0	257	134

	PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
⊙	PILOT STATION	232.0	24.5	208.0
△	AIRCRAFT CABIN	387.0	7.0 RT	215.0

NOTES:
1. MAIN ROTOR FUNDAMENTAL FREQUENCY = 4.3 Hz
2. OPEN SYMBOLS DENOTE LEFT TURN, CROSSED SYMBOLS DENOTE RIGHT TURN
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

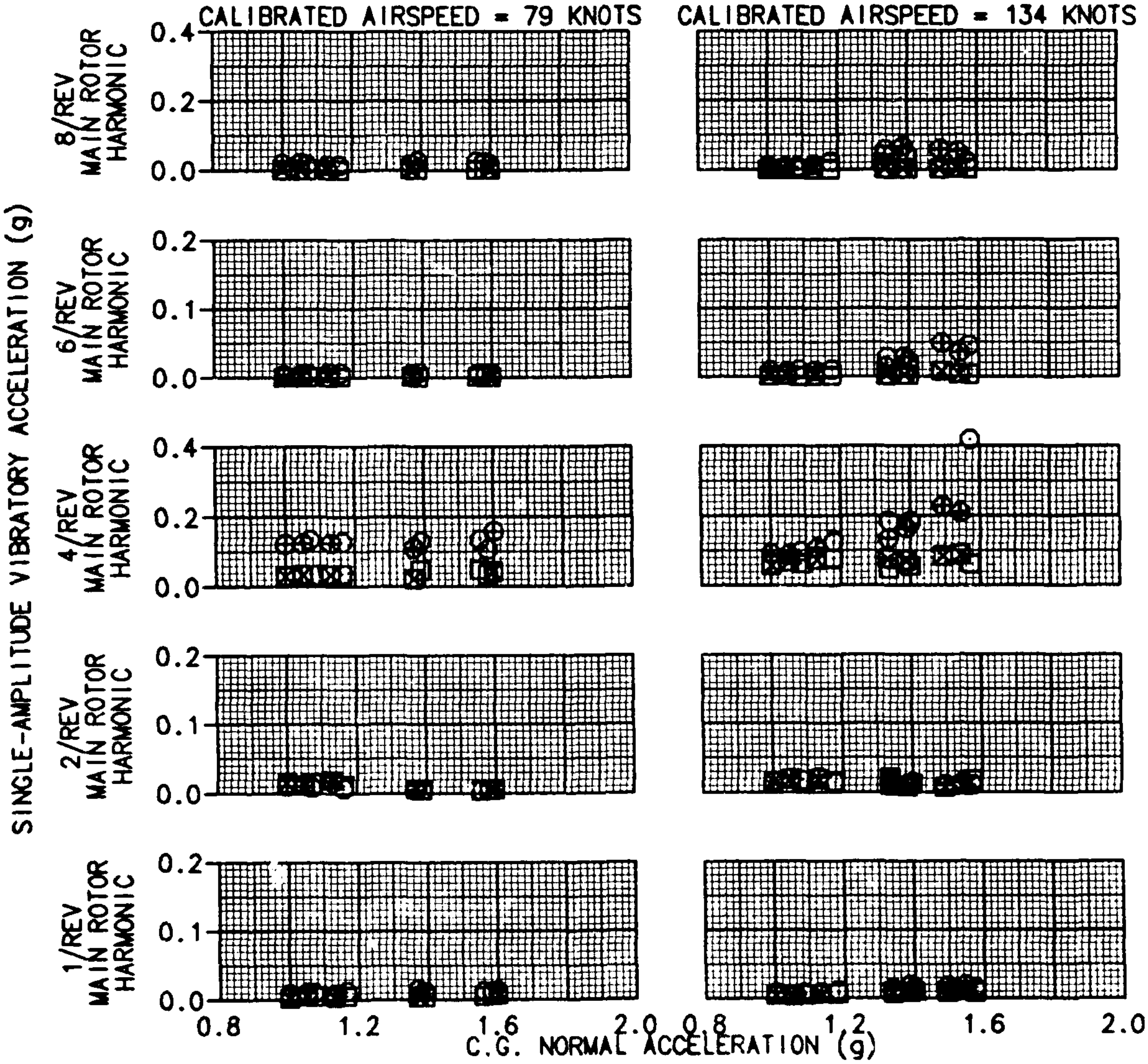


FIGURE E-60

VIBRATION CHARACTERISTICS IN TURNING FLIGHT

UH-60A USA S/N 82-23748

LONGITUDINAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	AVG CALIBRATED AIRSPEED (KT)
19540	361.0(AFT)	0.0	6060	16.0	258	79
18880	360.9(AFT)	0.0	6380	16.0	257	134

	PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
⊙	PILOT STATION	232.0	24.5	208.0
△	AIRCRAFT CABIN	387.0	7.0 RT	215.0

NOTES:
1. MAIN ROTOR FUNDAMENTAL FREQUENCY = 4.3 Hz
2. OPEN SYMBOLS DENOTE LEFT TURN, CROSSED SYMBOLS DENOTE RIGHT TURN
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

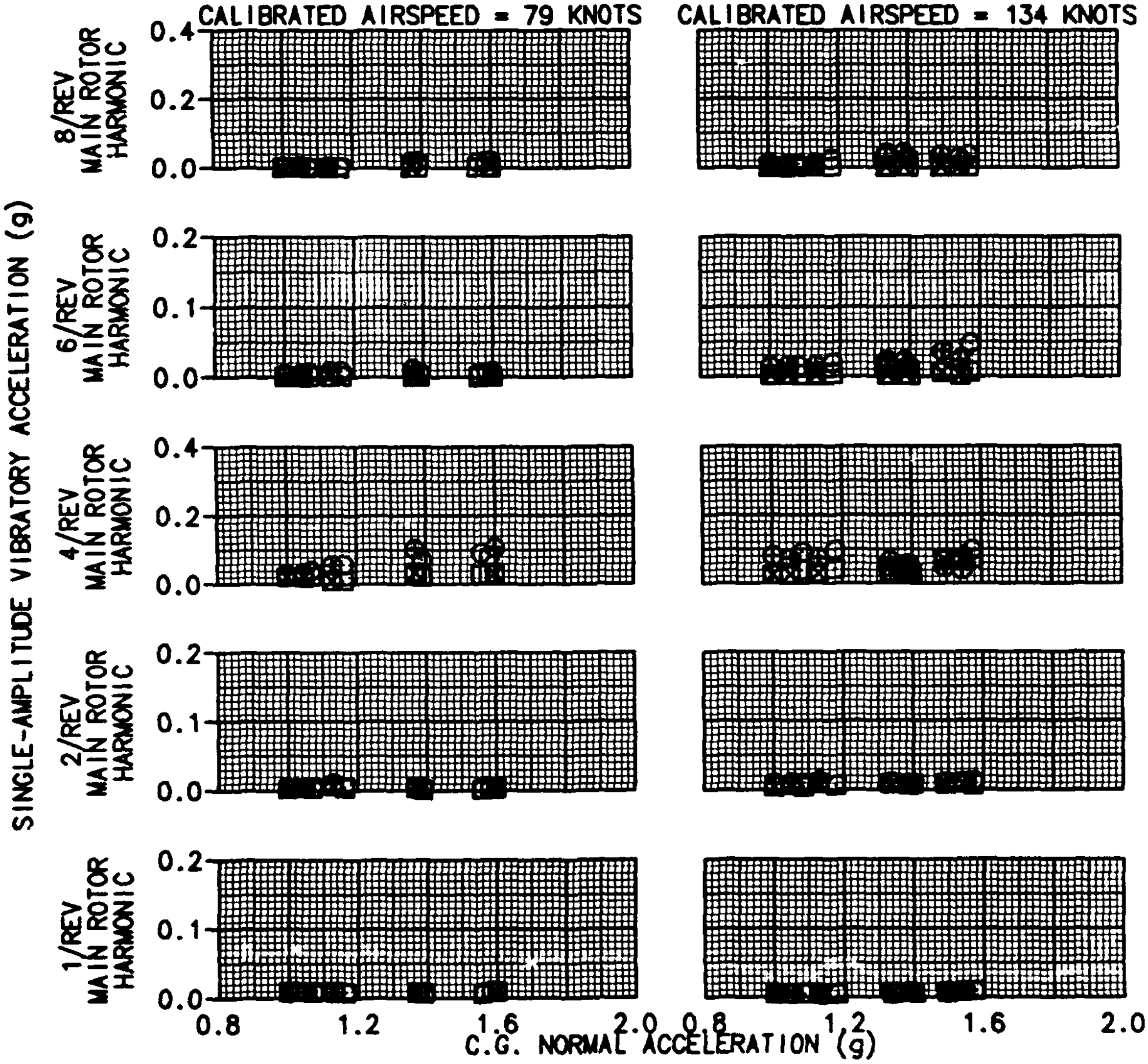


FIGURE E-61

VIBRATION CHARACTERISTICS IN TURNING FLIGHT

UH-60A USA S/N 82-23748

VERTICAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	AVG CALIBRATED AIRSPEED (KT)
19540	361.0(AFT)	0.0	6060	16.0	258	79
18880	360.9(AFT)	0.0	6380	16.0	257	134

	PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
○	PILOT STATION	232.0	24.5	208.0
△	AIRCRAFT CABIN	387.0	7.0 RT	215.0

NOTES: 1. MAIN ROTOR FUNDAMENTAL FREQUENCY = 4.3 Hz
2. OPEN SYMBOLS DENOTE LEFT TURN, CROSSED SYMBOLS DENOTE RIGHT TURN
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

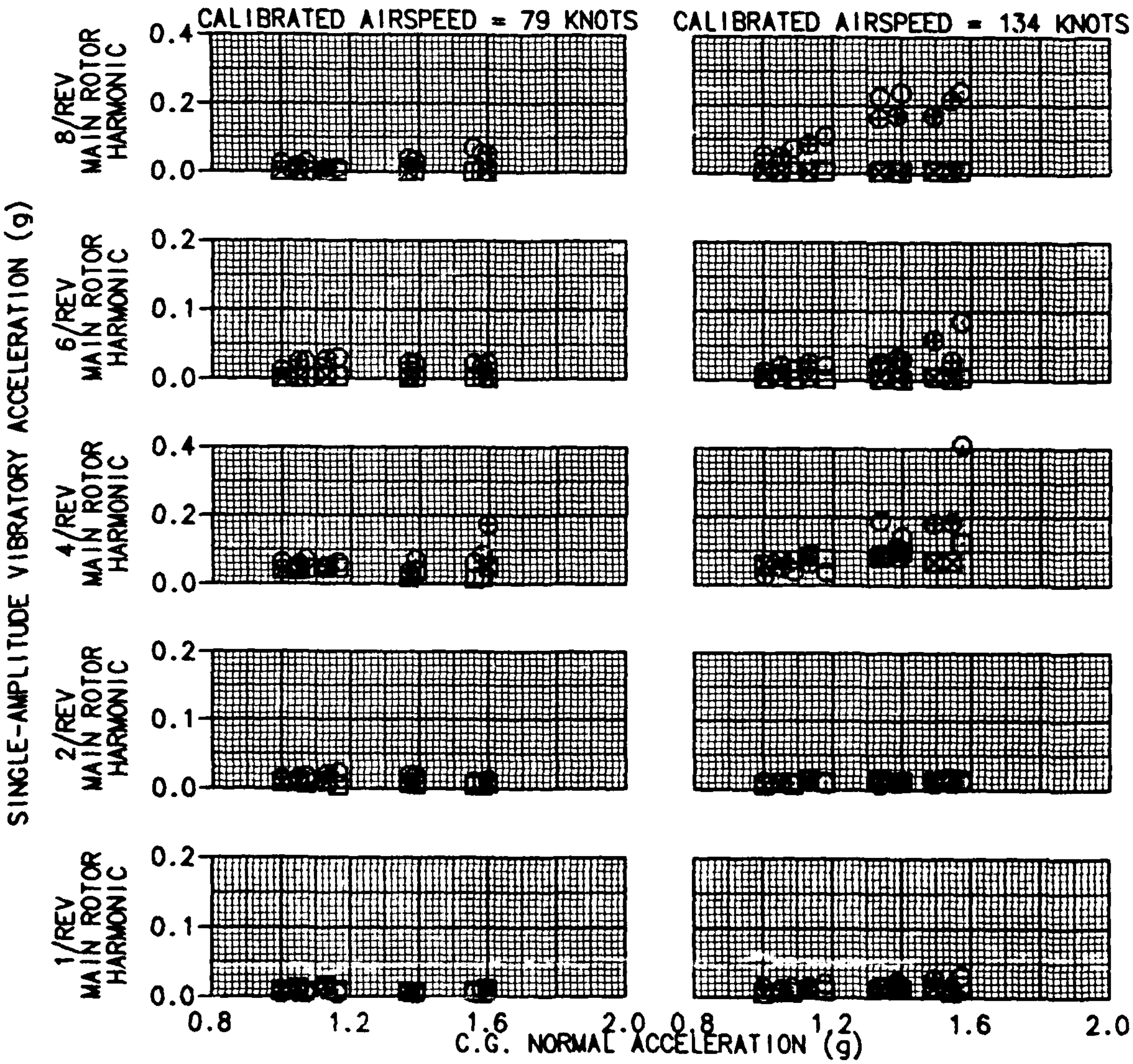


FIGURE E-62
STABILATOR VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

LATERAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
17390	348.1(FWD)	0.0	4690	18.5	260

PARAMETER	LOCATION FS	BL	WL
STABILATOR, CENTER	702.0	0.0	247.0

NOTES: 1. TAIL ROTOR FUNDAMENTAL FREQUENCY = 20.0 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

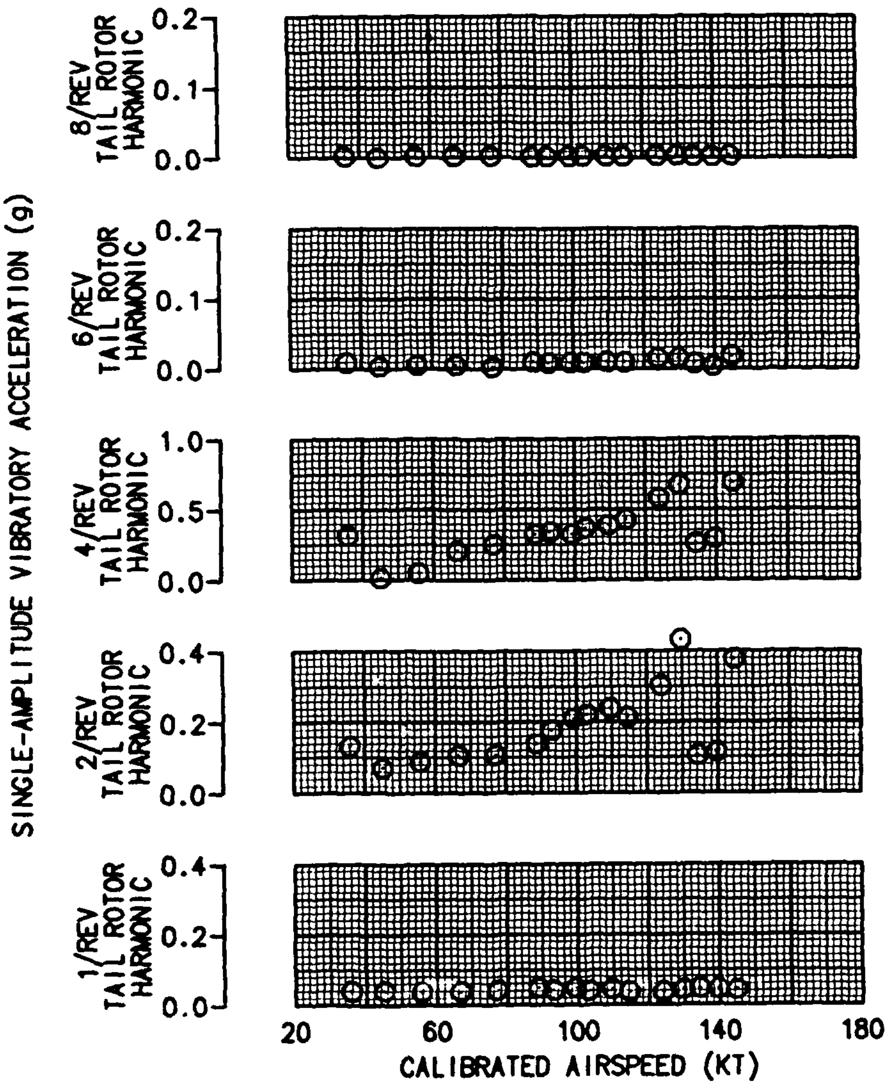


FIGURE E-63
STABILATOR VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

LATERAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
18630	347.2(FWD)	0.0	9010	4.0	253

PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
STABILATOR, CENTER	702.0	0.0	247.0

NOTES: 1. TAIL ROTOR FUNDAMENTAL FREQUENCY = 19.5 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

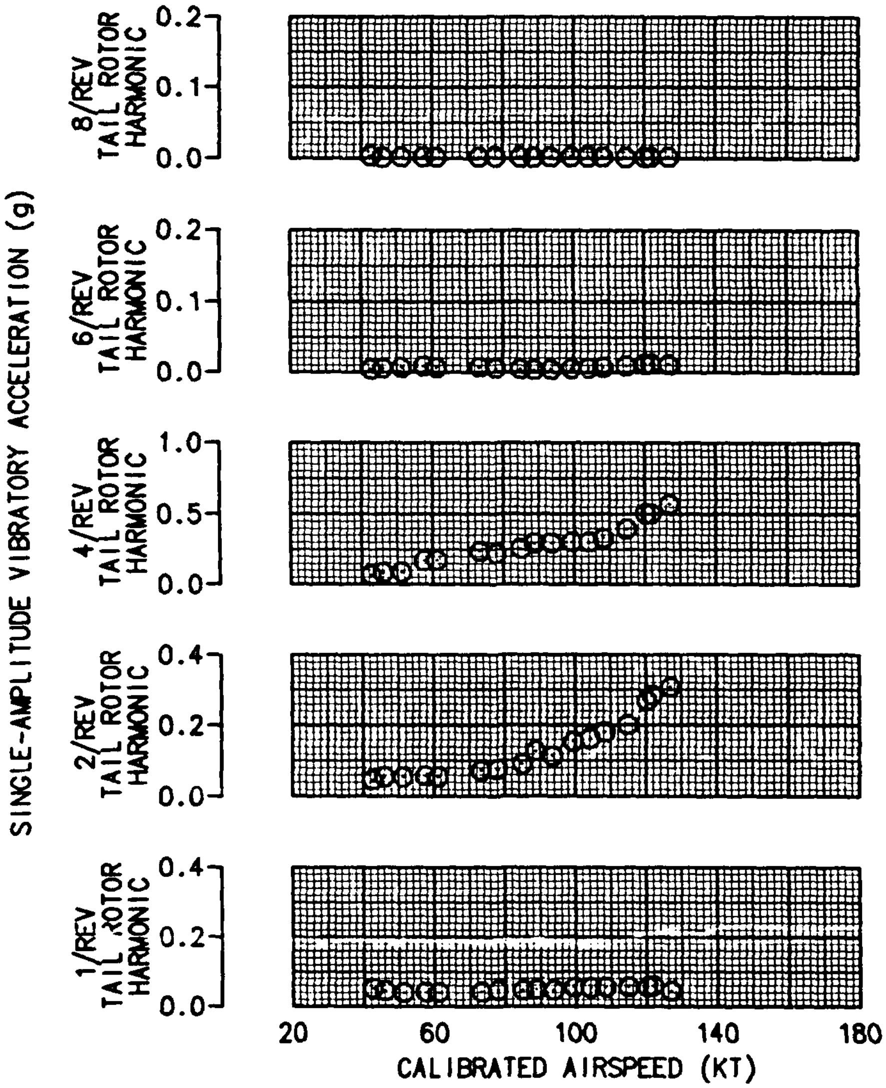


FIGURE E-64

STABILATOR VIBRATION CHARACTERISTICS IN LEVEL FLIGHT

UH-60A USA S/N 82-23748

LONGITUDINAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
17390	348.1(FWD)	0.0	4690	18.5	260

	PARAMETER	LOCATION FS	BL	WL
	STABILATOR, LEFT TIP	DATA NOT AVAILABLE		
Δ	STABILATOR, RIGHT TIP	702.0	83.5	247.0

NOTES: 1. TAIL ROTOR FUNDAMENTAL FREQUENCY = 20.0 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

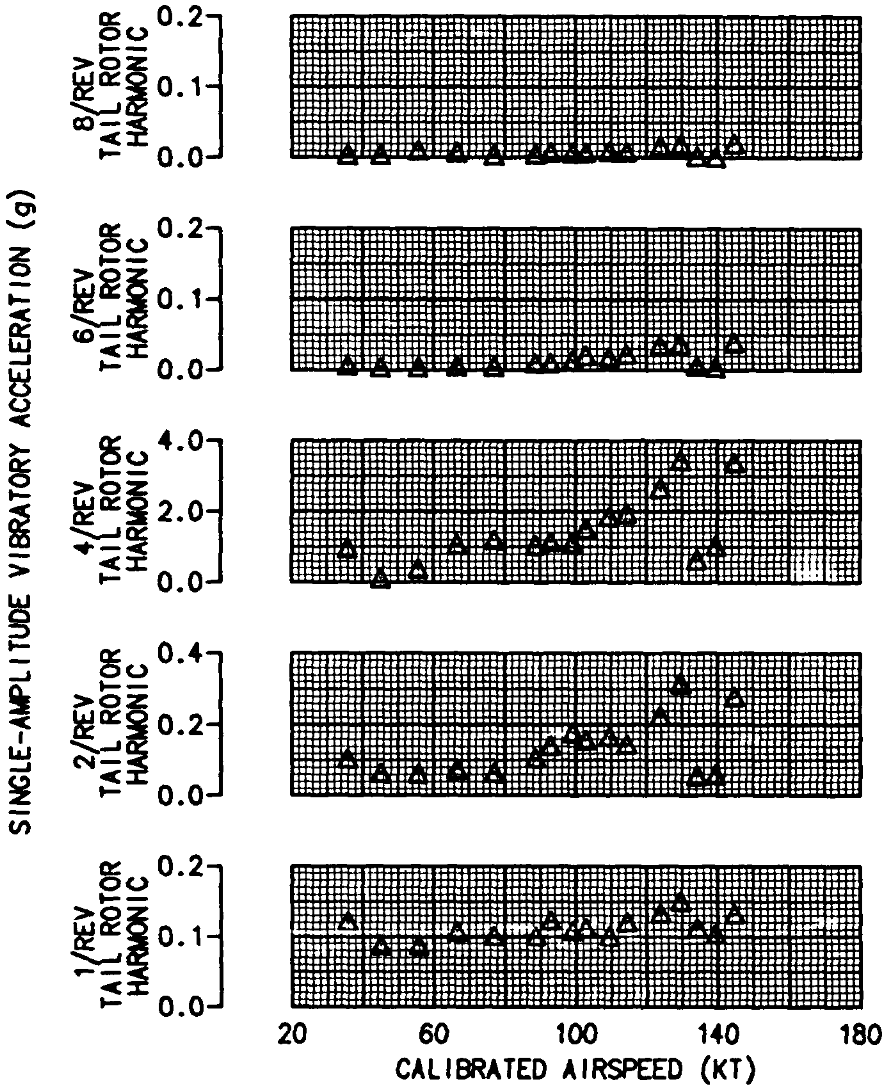


FIGURE E-65

STABILATOR VIBRATION CHARACTERISTICS IN LEVEL FLIGHT

UH-60A USA S/N 82-23748

LONGITUDINAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
18630	347.2(FWD)	0.0	9010	4.0	253

	PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
□	STABILATOR, LEFT TIP	702.0	-83.5	247.0
Δ	STABILATOR, RIGHT TIP	702.0	83.5	247.0

NOTES: 1. TAIL ROTOR FUNDAMENTAL FREQUENCY = 19.5 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

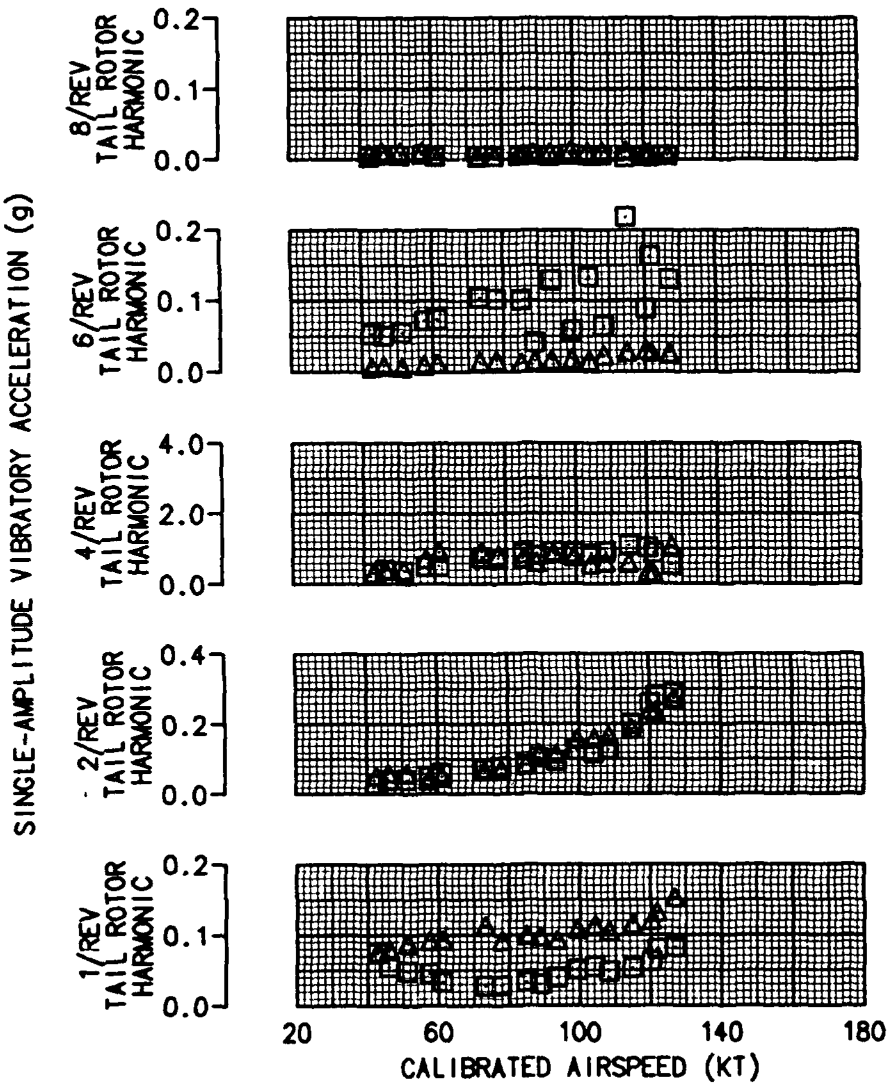


FIGURE E-66

STABILATOR VIBRATION CHARACTERISTICS IN LEVEL FLIGHT

UH-60A USA S/N 82-23748

VERTICAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
17390	348.1(FWD)	0.0	4690	18.5	260

	PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
□	STABILATOR, LEFT TIP	702.0	-83.5	247.0
△	STABILATOR, RIGHT TIP	702.0	83.5	247.0
○	STABILATOR, CENTER	702.0	0.0	247.0

NOTES: 1. TAIL ROTOR FUNDAMENTAL FREQUENCY = 20.0 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

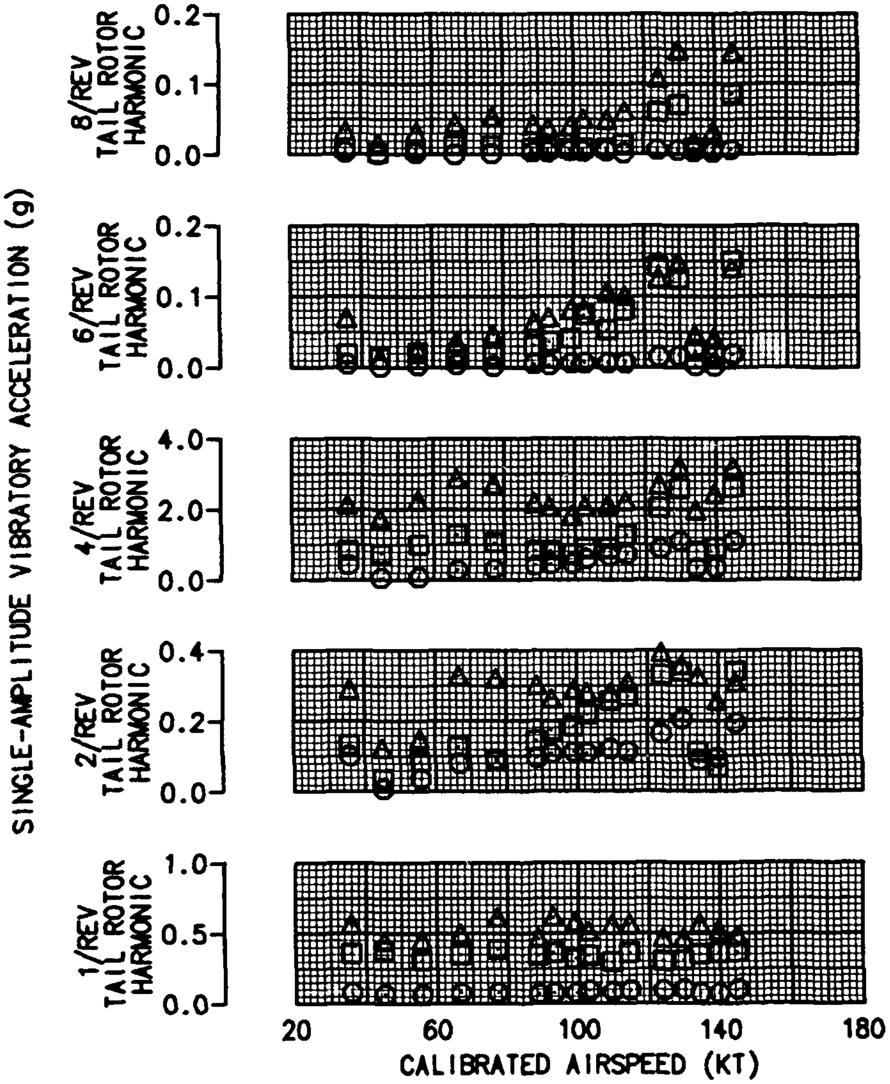


FIGURE E-67
STABILATOR VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

VERTICAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
18630	347.2(FWD)	0.0	9010	4.0	253

	PARAMETER	LOCATION FS	BL	WL
□	STABILATOR, LEFT TIP	702.0	-83.5	247.0
△	STABILATOR, RIGHT TIP	702.0	83.5	247.0
⊙	STABILATOR, CENTER	702.0	0.0	247.0

NOTES: 1. TAIL ROTOR FUNDAMENTAL FREQUENCY = 19.5 Hz
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

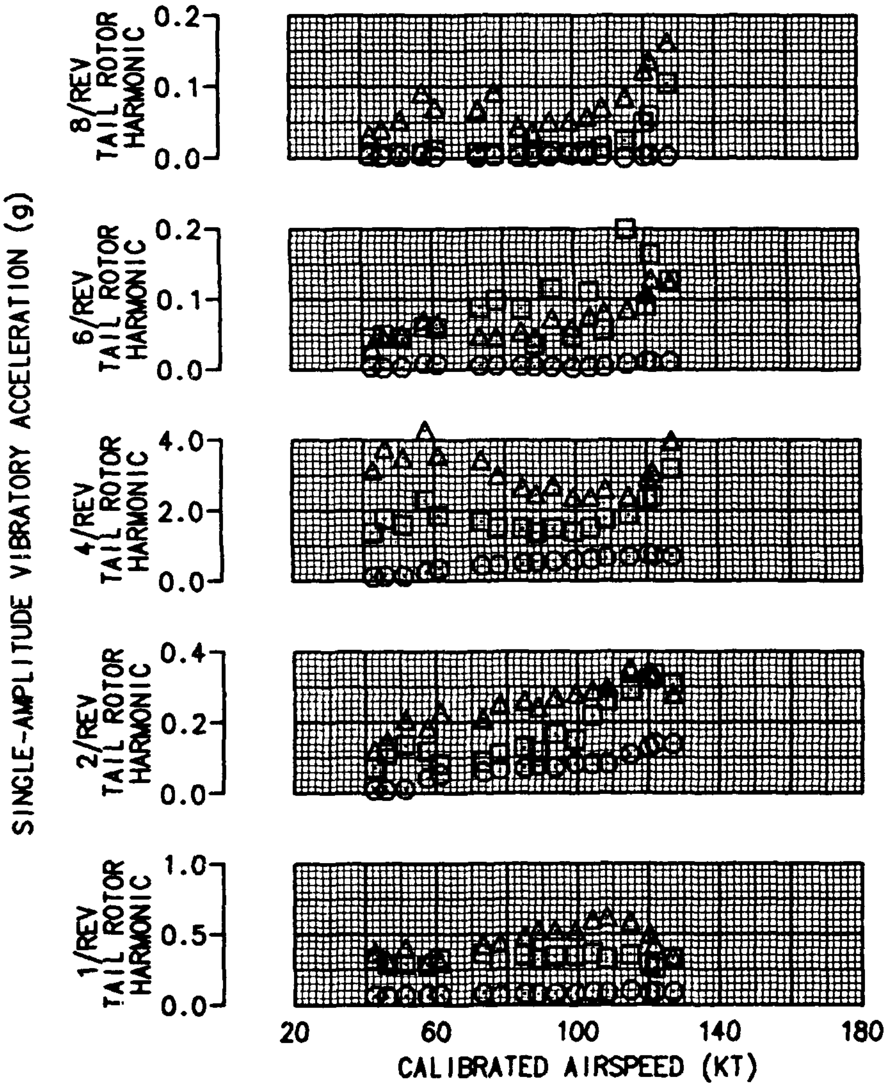


FIGURE E-68
STABILATOR VIBRATION CHARACTERISTICS IN TURNING FLIGHT
UH-60A USA S/N 82-23748

LATERAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	AVG CALIBRATED AIRSPEED (KT)
19540	361.0(AFT)	0.0	6060	16.0	258	79
18880	360.9(AFT)	0.0	6380	16.0	257	134

PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
STABILATOR, CENTER	702.0	0.0	247.0

NOTES:
1. TAIL ROTOR FUNDAMENTAL FREQUENCY = 19.8 Hz
2. OPEN SYMBOLS DENOTE LEFT TURN, CROSSED SYMBOLS DENOTE RIGHT TURN
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

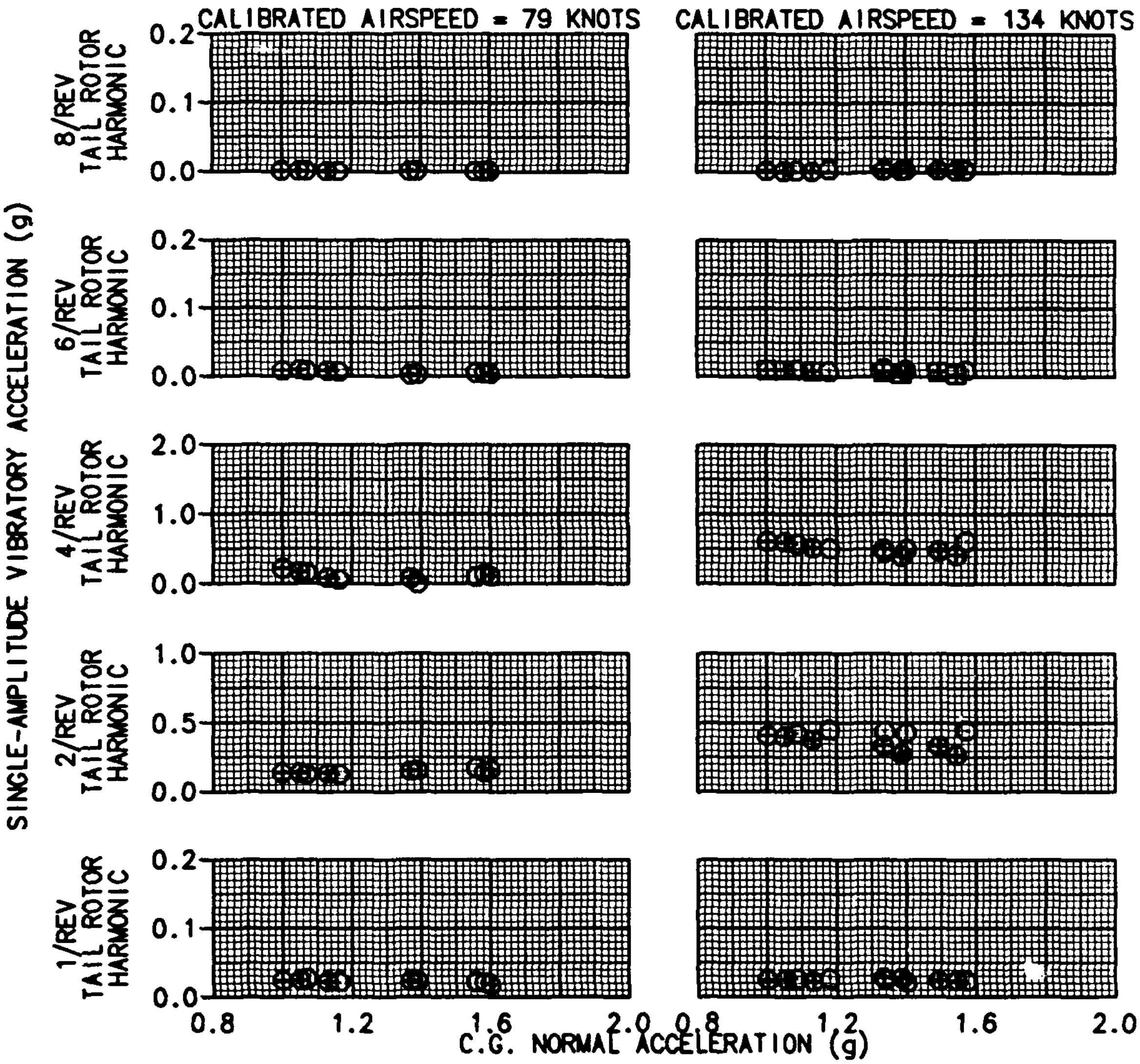


FIGURE E-69
STABILATOR VIBRATION CHARACTERISTICS IN TURNING FLIGHT
UH-60A USA S/N 82-23748

LONGITUDINAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	AVG CALIBRATED AIRSPEED (KT)
19540	361.0(AFT)	0.0	6060	16.0	258	79
18880	360.9(AFT)	0.0	6380	16.0	257	134

	PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
□	STABILATOR, LEFT TIP	702.0	-83.5	247.0
△	STABILATOR, RIGHT TIP	702.0	83.5	247.0

NOTES:
1. TAIL ROTOR FUNDAMENTAL FREQUENCY = 19.8 Hz
2. OPEN SYMBOLS DENOTE LEFT TURN, CROSSED SYMBOLS DENOTE RIGHT TURN
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

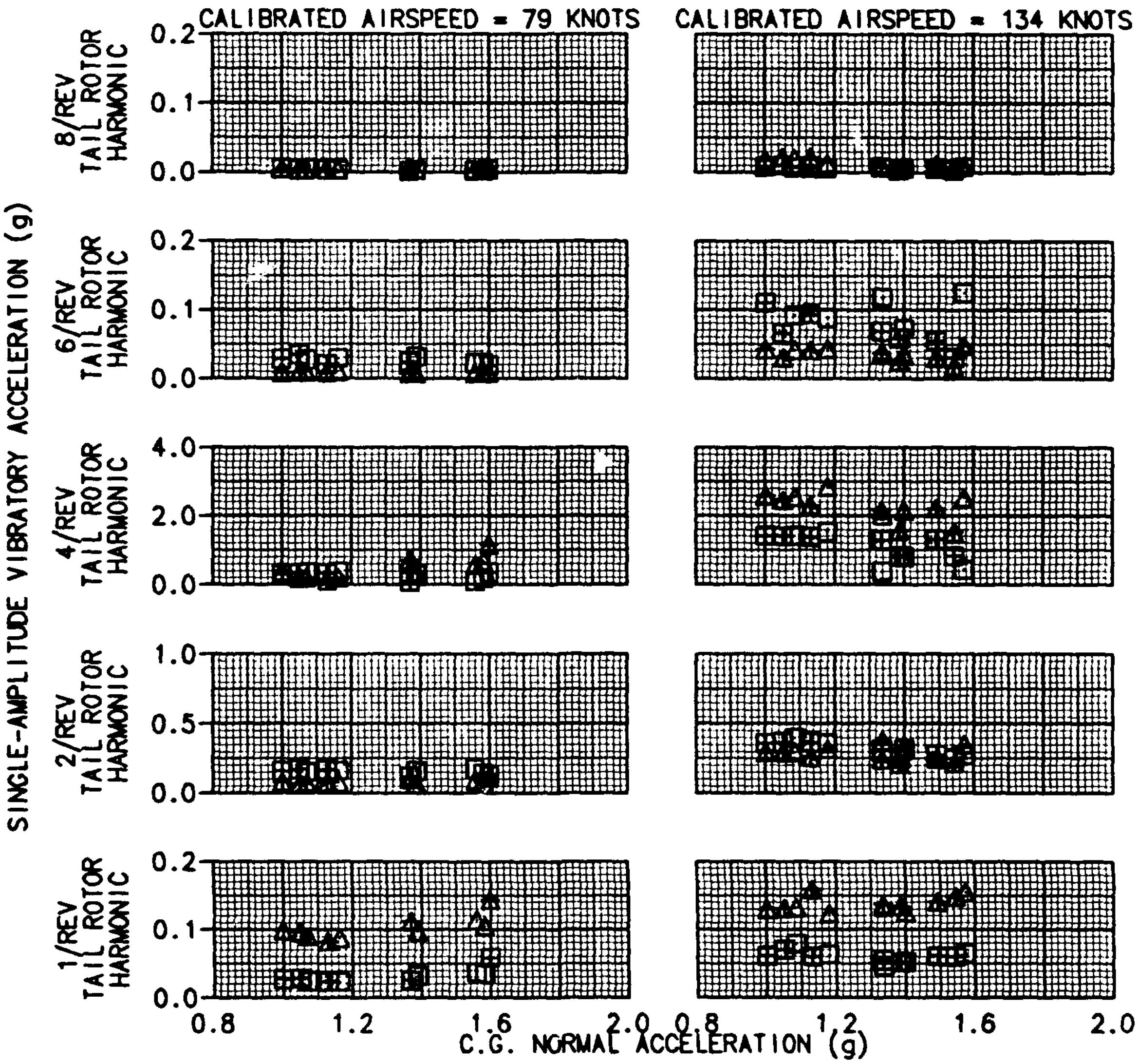


FIGURE E-70

STABILATOR VIBRATION CHARACTERISTICS IN TURNING FLIGHT

UH-60A USA S/N 82-23748

VERTICAL ACCELERATION

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	AVG CALIBRATED AIRSPEED (KT)
19540	361.0(AFT)	0.0	6060	16.0	258	79
18880	360.9(AFT)	0.0	6380	16.0	257	134

	PARAMETER	LOCATION FS	LOCATION BL	LOCATION WL
□	STABILATOR, LEFT TIP	702.0	-83.5	247.0
△	STABILATOR, RIGHT TIP	702.0	83.5	247.0
⊙	STABILATOR, CENTER	702.0	0.0	247.0

NOTES:
1. TAIL ROTOR FUNDAMENTAL FREQUENCY = 19.8 Hz
2. OPEN SYMBOLS DENOTE LEFT TURN, CROSSED SYMBOLS DENOTE RIGHT TURN
3. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO TANKS

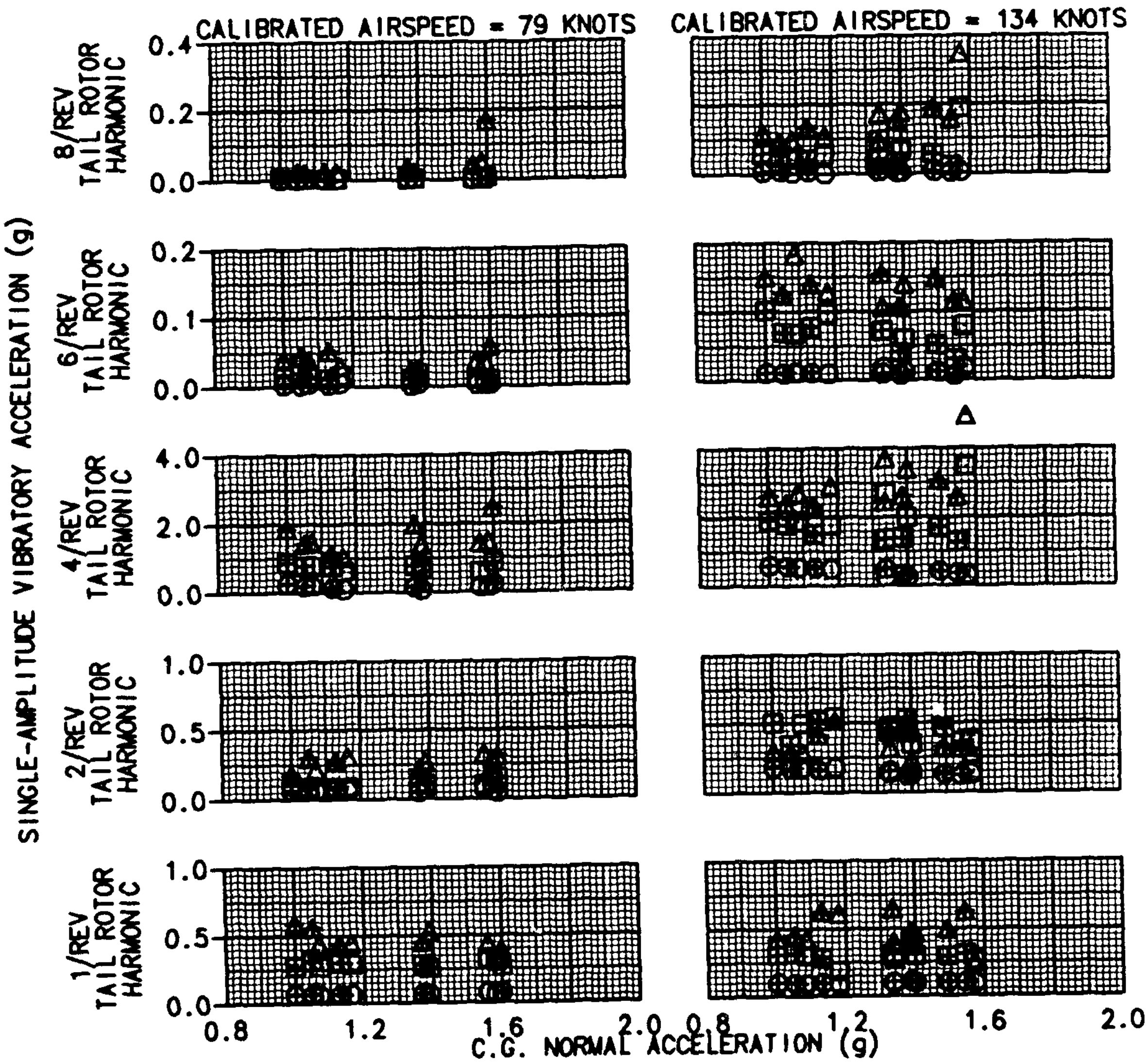


FIGURE E-71
SHIP SYSTEM AIRSPEED CALIBRATION
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)	TRIM FLIGHT CONDITION
17590	349.2	0.0	7520	11.0	256	LEVEL

NOTES: 1. TRAILING BOMB METHOD
2. AIRCRAFT CONFIGURATION: EXTERNAL FUEL SYSTEM, TWO 230-GALLON TANKS

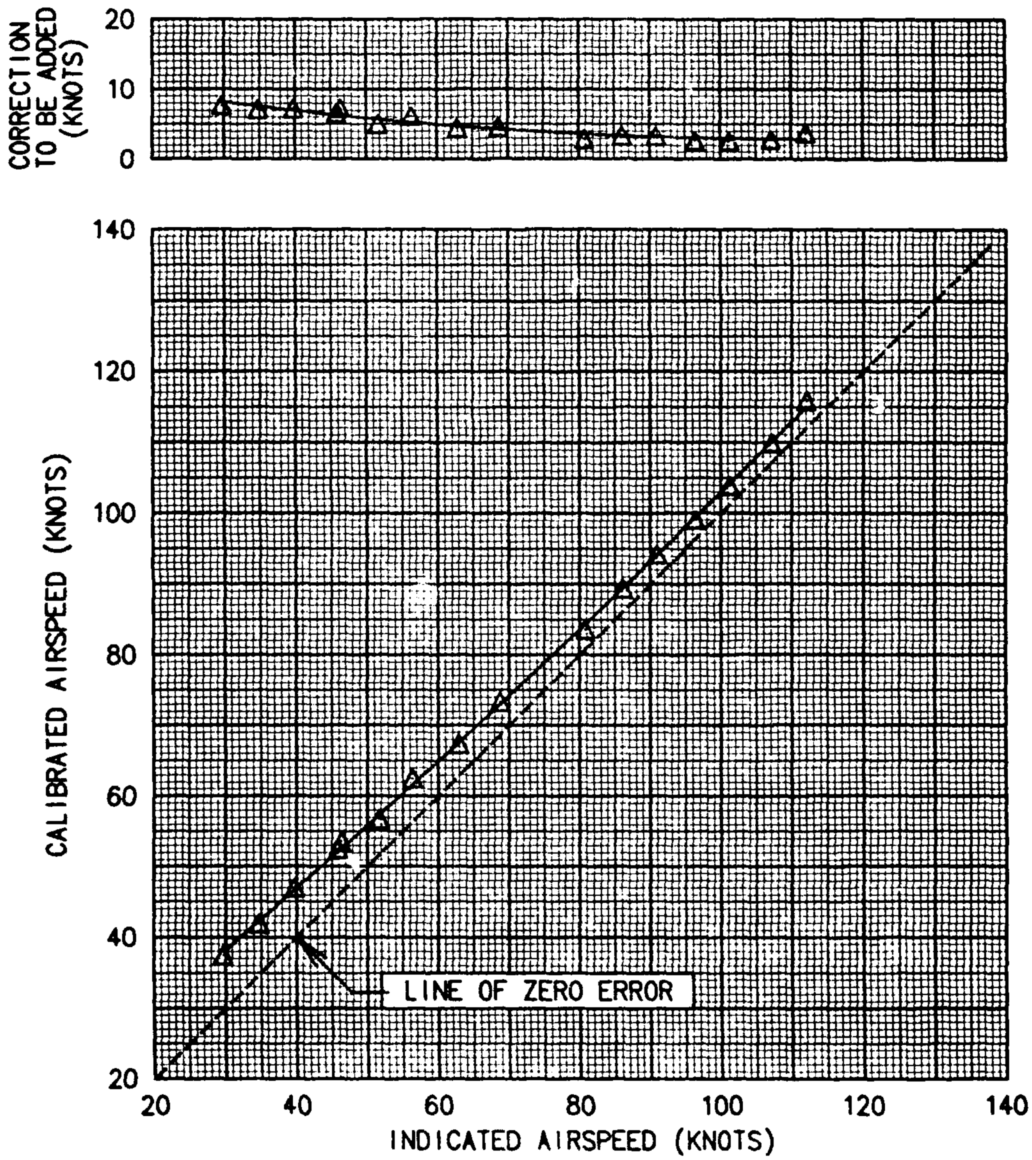
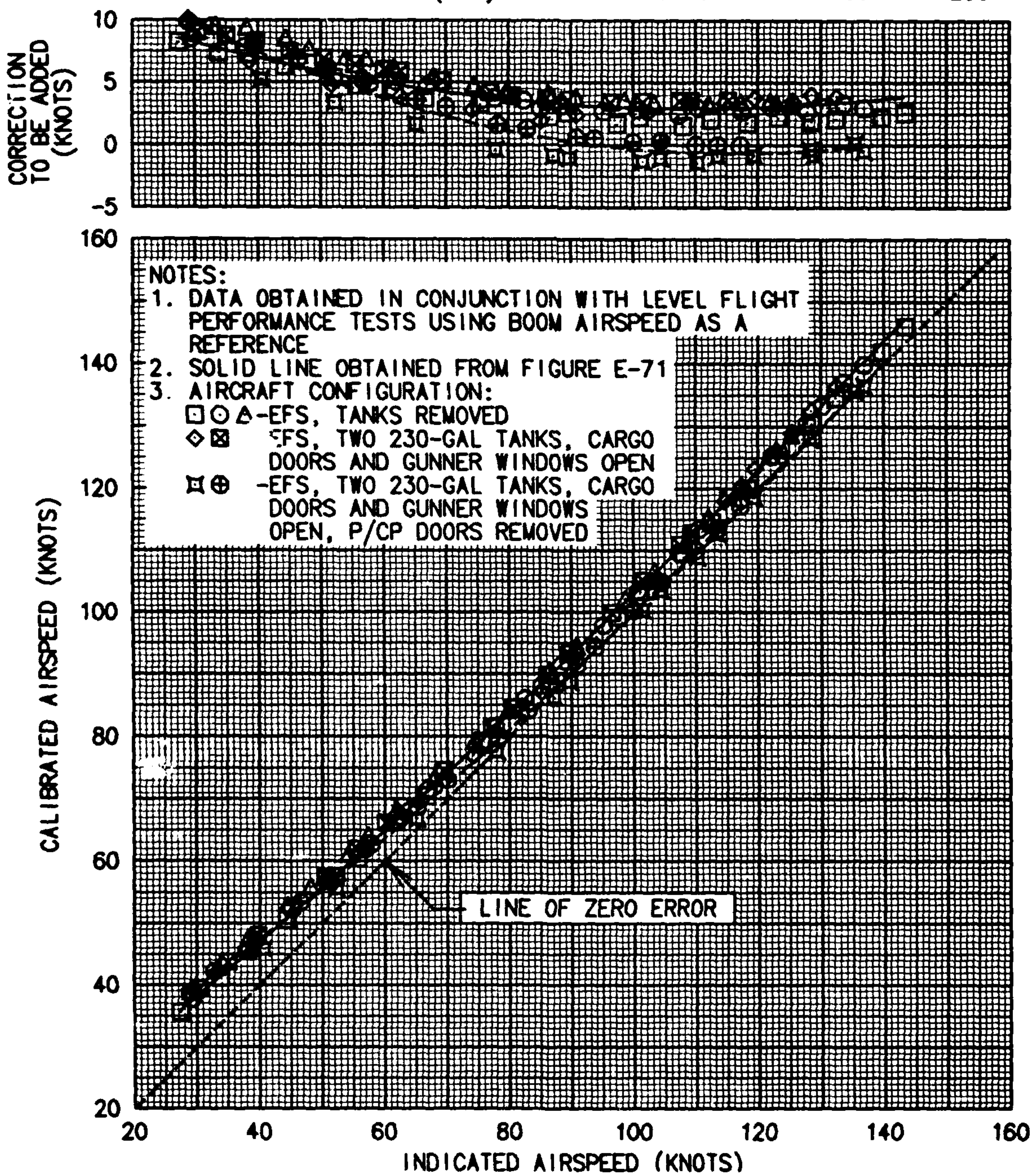


FIGURE E-72

SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG C.G. LOCATION LONG (FS)	AVG C.G. LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FEET)	AVG OUTSIDE AIR TEMP. (DEG C)	AVG ROTOR SPEED (RPM)
⊡	17250	347.7(FWD)	0.0	5040	19.0	260
⊙	18170	347.6(FWD)	0.0	7040	13.0	257
△	18800	347.1(FWD)	0.0	9190	9.5	256
◇	17480	347.8(FWD)	0.0	4170	15.5	258
⊠	18970	347.2(FWD)	0.0	9510	14.0	258
⌑	17240	347.4(FWD)	0.0	3850	9.0	255
⊕	18810	347.1(FWD)	0.0	9710	14.0	258



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6520 Test Group (ENML)	1
Commander, Naval Air Systems Command (AIR 5115B, AIR 5301)	3
Defense Intelligence Agency (DIA-DT-2D)	1
School of Aerospace Engineering (Dr. Daniel P. Schrage)	1
Headquarters United States Army Aviation Center and Fort Rucker (ATZQ-ESO-L)	1
US Army Aviation Systems Command (AMSAV-EA)	1
US Army Aviation Systems Command (AMSAV-ECU)	1
US Army Aviation Systems Command (AMCPM-BH)	1
US Army Aviation Systems Command (AMSAV-6)	2
US Army Aviation Systems Command (AMSAV-ED)	1
US Army Aviation Center (ATZQ-CDM-CS)	1